

# The AMSAT<sup>®</sup> Journal

*Editor*  
Russ Tillman, KC5JVB

*Editorial Staff*  
Ron Long, W8GUS  
Buzz Gorsky, WH6I  
Andy Reynolds, WD9IYT

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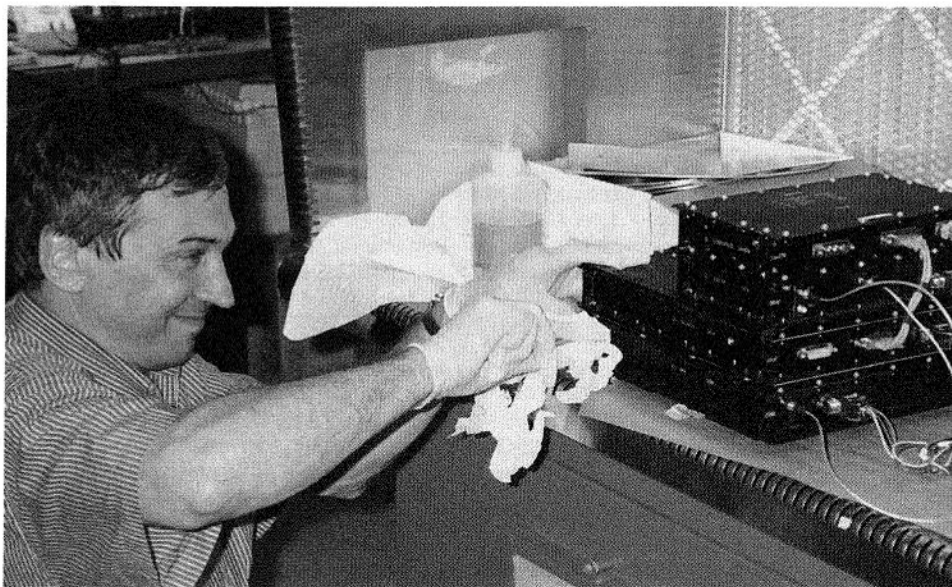
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Freddy de Guchteneire, ON6UG performs a final cleaning on the S-Band (2.4 GHz) Transmitter just prior to its installation into the Phase 3D satellite at the Phase 3D Integration Laboratory in Orlando, Florida. The transmitter produced a clean 50 Watts output while mounted in Phase 3D during subsequent tests. (AMSAT-NA photo by Keith Baker, KB1SF)

## Phase 3D Work Nears Completion While Launch Uncertain

On Wednesday, July 16, 1997 a meeting was held in Marburg, Germany attended by Dr. Karl Meinzer DJ4ZC, Phase 3D Project Leader and AMSAT-DL President; Werner Haas DJ5KQ, AMSAT-DL Vice President; and officials of the European Space Agency (ESA). The purpose of the meeting was to discuss the launch schedule for Ariane 502, on which the Phase 3D spacecraft is scheduled to fly.

At this meeting, the ESA officials reiterated their intent to launch Ariane 502 at the end of September and said that the launch campaign for this flight has already begun. They also stated that, as part of this launch campaign, the Phase 3D spacecraft must arrive at ESA's Launch Center in Kourou, French Guyana by August 10, 1997.

[continued on page 4]



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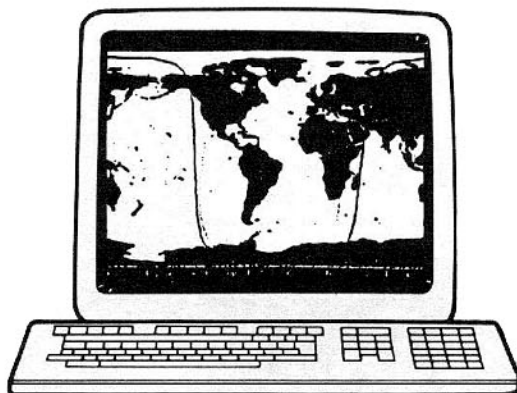
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Telephone: 301-589-6062 - <http://www.amsat.org>

The AMSAT Journal Staff:  
Editor in Chief: Russell K. Tillman, KC5JVB  
Circulation: Martha Saragovitz  
([martha@amsat.org](mailto:martha@amsat.org))

Editorial Staff:  
Ron Long, W8GUS  
Buzz Gorsky, WH6I  
Andrew Reynolds, WD9IYT

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Editorial Office: Russ Tillman, KC5JVB, 113 Rollingwood Drive,  
Vicksburg, MS 3910-9510, Internet: [kc5jvb@amsat.org](mailto:kc5jvb@amsat.org), telephone and fax:  
601-634-6398.

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## Apogee View

### How Does it With Phase 3D?

by Bill Tynan W3XO

It was announced in AMSAT News Service (ANS) Bulletin 208.01 of July 27, 1997 that, due to the necessity of performing a number of significant mechanical modifications to the Phase 3D spaceframe made necessary by a late change in ESA launch environment specifications, the schedule for the launch of Ariane 502 and the Phase 3D schedule were no longer compatible. As a result, ESA concluded that Phase 3D would not be able to fly on that mission.

This announcement prompted several derogatory comments regarding ESA and its action to be posted to AMSAT-NA's Internet open mail service, AMSAT-BB. I want to say at the outset that such comments are not helpful to the ongoing efforts to identify another launch for Phase 3D; and make it absolutely clear that they do not represent the opinion of AMSAT-NA, or any other AMSAT group. Unlike the AMSAT News Service (ANS), which is the official voice of AMSAT-NA; AMSAT-BB postings in no way reflect the opinions of AMSAT-NA or any other AMSAT group. AMSAT-BB is simply a mail reflector, open to anyone and therefore, represents only the views held by the person posting the message, at that particular moment. Furthermore, AMSAT-NA, in no way, limits what people say on AMSAT-BB, nor do we intend to. Therefore, nothing posted on AMSAT-BB *should ever* be construed as representing the official opinions or policies of any AMSAT organization. Such official opinions or policies will be posted to ANS or presented in official publications such as this Journal. Despite their unofficial status, some people reading AMSAT-BB postings may erroneously conclude that, because they appear on an AMSAT-NA sponsored mail reflector, they somehow represent AMSAT official opinion. Therefore, derogatory statements by individuals, appearing on AMSAT-BB or other public forums, could potentially negatively affect very delicate negotiations to secure another launch for Phase 3D.

Additionally, it should be noted that ESA has been very supportive of AMSAT for almost twenty years. The first Phase 3 satellite was a passenger on an Ariane vehicle which,

unfortunately, ended in a launch failure in 1980. ESA made amends for this loss by launching AO-10 three years later. This was followed by AO-13 in 1988, the four Microsats and two UoSats in 1990, and later, KO-23, KO-25, IO-26 and AO-27. All of these satellites were launched by ESA on Ariane vehicles. So, it is clear that, since the early 1980s, the European Space Agency has been responsible for the launch of most of the amateur spacecraft, other than those orbited by the Russians and the Japanese.

There is no reason to believe that ESA's support for AMSAT projects has waned. The decision made with respect to Phase 3D is apparently one of schedule incompatibility only. It should be clear to everyone that it is vital to ESA that the Ariane 502 flight goes well; and that it is launched in accordance with the established schedule, if at all possible. Needless to say, it is also in AMSAT's best interest that it is a great success, even without Phase 3D aboard.

Similar sentiments were expressed at a Phase 3D Program Board meeting held August 30 at the Phase 3D Integration Laboratory in Orlando to review the status of the Project. Participants in that meeting were AMSAT-DL President and Phase 3D Project Leader Dr. Karl Meinzer DJ4ZC, Werner Haas DJ5KQ AMSAT-DL Vice President, Peter Guelzow DB2OS representing the Command Station Team, Ron Broadbent G3AAJ AMSAT-UK Secretary, Joel Harrison W5ZN representing ARRL, Keith Baker KB1SF AMSAT-NA Executive Vice President and myself.

As to Phase 3D, I can report that, as of this writing, the mechanical modifications are going well and should be completed shortly. They have necessitated the removal, sometimes several times, of most of the electronic modules that were already installed. These are currently in the process of being reinstalled and retested. A contingent of folks from Germany, Belgium, the Czech Republic, Slovenia and Japan were in Orlando during the latter half of August to accomplish much of this work. Just prior to that, the RUDAK crew was at the Integration Lab to install and check out that interesting and important sub-system. But, it is clear that the mechanical modifications have materially delayed the installation and checkout of the various electronic systems. Thus, it is likely that



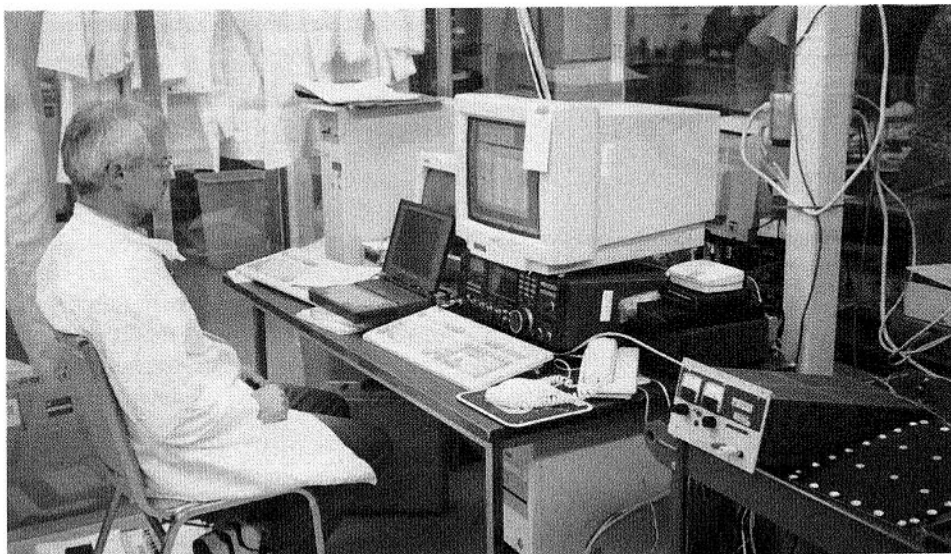
another trip by several of our European compatriots will be necessary before the spacecraft can be declared complete.

In addition to delaying completion of Phase 3D, the mechanical modifications have cost AMSAT-NA at least \$25,000 in addition to expenses already anticipated. So, it goes without saying that further contributions would be most welcome. Don't forget the Major Donor campaign. Those individuals or organizations contributing a total of \$2,500 to the Project, will have a piece of spacecraft hardware, such as a row of solar cells, dedicated to them. And, they will be presented with a large plaque documenting the specific hardware that has been so dedicated. In addition, those contributing a total of \$1,000 will receive an attractive plaque to commemorate their help to Phase 3D. For both of these fund raising efforts, contributions made directly to AMSAT-NA since the beginning of the Project count toward the total. Therefore, you may not have to add much to qualify for one of these awards. The AMSAT-NA office can provide information as to the amount already credited to you.

It is imperative that all of us do everything we can to promote the successful launch of Phase 3D. This means *each* of us contributing financially to the Project to the best of our ability. It also means being especially careful of what we say on public forums such as AMSAT-BB or in letters to the editors of various magazines. Let's not do anything that could possibly hinder DJ4ZC in his continuing negotiations with ESA representatives. I am sure that he, and the ESA folks, are doing their very best to secure another launch for Phase 3D.

All of us need to support their efforts and wish them the best of success. I remain confident that they will ultimately reach agreement for another Phase 3D launch.

Keep tuned. And keep the faith. ■



Jim White, WD0E, checks out the flight RUDAK experiment just prior to installation into Phase 3D during recent integration efforts at the Phase 3D Integration Laboratory, Orlando, Florida. The flight RUDAK module is shown in the lower right portion of the photograph as the black box on the cart next to the power supply. (AMSAT-NA photo by Keith Baker, KB1SF)

#### [PHASE 3D continued from page 1]

Earlier, ESA had informed AMSAT that, following analysis of data from the Ariane 501 flight, they had significantly increased their estimates for the acceleration and vibration environment which the spacecraft riding on Ariane 502 are expected to encounter. As a result of this new information, AMSAT has been reevaluating the structural capabilities of the Phase 3D spaceframe.

As a part of this effort, an independent structural engineer was brought in to review the spacecraft's design and construction. His conclusions were recently presented to Dr. Meinzer and AMSAT-NA people. His report stated that, in order to be confident of Phase 3D surviving the stresses from this increased launch environment, a number of modifications must be made to the spacecraft. Since that report was presented, substantial effort has been taking place at the Phase 3D Integration Laboratory in Orlando, Florida to manufacture and install the recommended

structural parts necessary to increase the spacecraft's vibration and acceleration capabilities.

At the Marburg meeting, Dr. Meinzer made it clear to ESA officials that this work, made necessary by ESA's new environmental information, would prevent AMSAT from delivering the spacecraft to Kourou by the specified

August 10th date. Thus, it was the conclusion of the meeting that, as a result of these ESA specification changes, the Phase 3D schedule and that of ESA for Ariane 502 are not currently compatible. That is, unless something changes (a situation which ESA does not presently contemplate) Phase 3D will not be able to launch on Ariane 502.

Furthermore, in order to maintain the planned mass characteristics of the Ariane 502 vehicle, AMSAT must now also supply ESA with a mass simulator representing the (possibly absent) Phase 3D spacecraft to be sent aloft on the flight. This simulator must be in Kourou by September 5th.

Despite this very bad news, Dr. Meinzer and other AMSAT officials expressed some degree of confidence that Phase 3D may yet fly on Ariane 502. This confidence is based on a number of activities taking place in the preparation of the launch vehicle that AMSAT officials believe could cause a slip in the currently published ESA schedule.

ESA officials attending the Marburg meeting said that if such a slip should occur (again, a situation which ESA does not currently contemplate) and the slip results in the two schedules becoming compatible once more, efforts would be made to substitute the Phase 3D spacecraft for the mass simulator. Therefore, AMSAT is continuing work on completing the necessary structural modifications to the Phase 3D spacecraft as well as conducting environmental testing.

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## Phase 3D Integration Continues

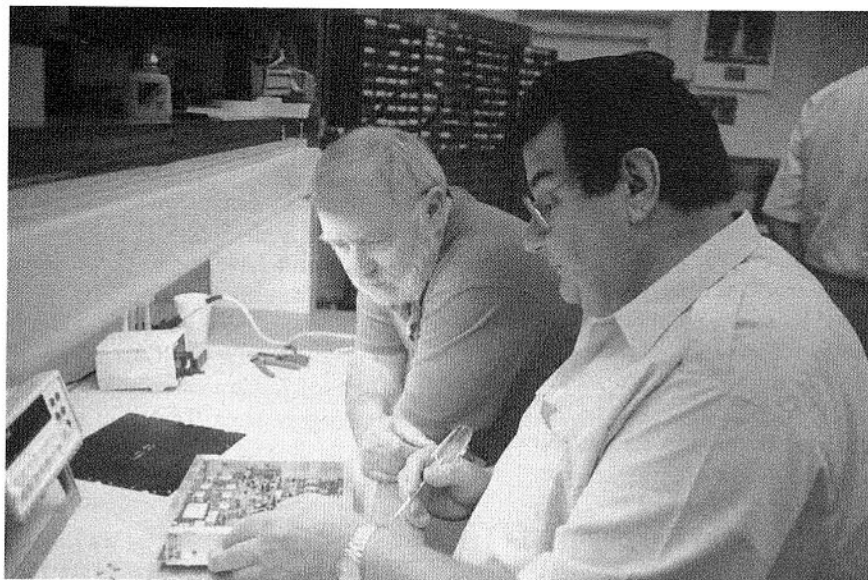
An international team of Phase 3D project workers assembled August 18th at the Phase 3D Integration Laboratory in Orlando, Florida, U.S.A. to continue the final mechanical and electronic integration efforts on the satellite. Teams from Germany, Belgium, Slovenia, Hungary, Japan and the Czech Republic joined their American counterparts in an all-out marathon to prepare the satellite as quickly as possible for a safe and successful launch.

"We are happy to join our American partners in this effort" said Werner Haas, DJ5KQ, AMSAT-DL's Vice President, who also headed the European contingent. "The cooperation has, once again been excellent between our two groups" he said.

Even before our overseas compatriots arrived, workers at the Orlando Integration Lab were racing to make the needed structural modifications to the satellite since it became known that Phase 3D would, during its planned Ariane 502 launch, most likely encounter environmental loads greater than those originally stated.

Keith Baker, KB1SF, AMSAT-NA Executive Vice President reports from Orlando that these significant mechanical upgrade efforts are proceeding. "The folks here at the Lab have been burning the midnight oil over the past several weeks to make these structural changes on a work schedule where 16 to 18 hour work days have been the norm, rather than the exception", Keith said. He went on the note that, "These people have done an absolutely superb job under some extremely difficult circumstances. We all owe them a tremendous debt of gratitude for their outstanding work."

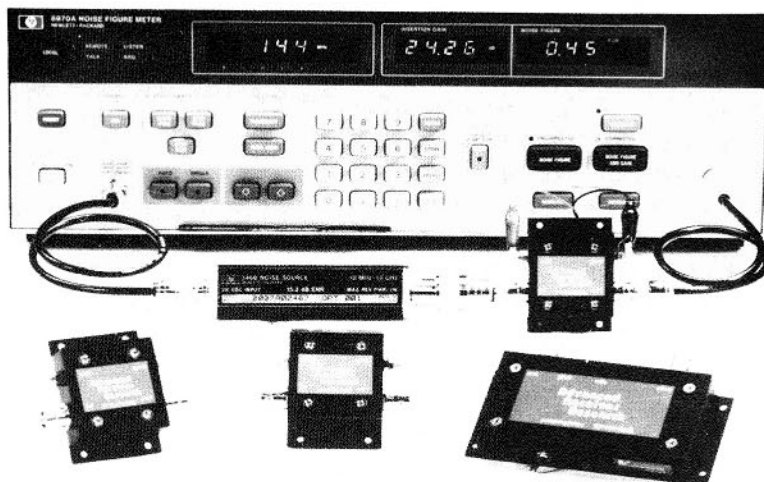
Over the last week, these round-the-clock efforts continued with the combined team's current activities installing and checking out a significant number of the remaining electronic and mechanical pieces into the satellite. Such efforts included installation and checkout of the spacecraft's momentum wheels, the RUDAK digital experiment, the 2.4 GHz and 24 GHz transmitters as well as a number of other transmitters, receivers and other equipment, some of which were being re-installed after having been previously removed to facilitate the structural modifications. ■



AMSAT-NA Phase 3D Integration Laboratory Manager Lou McFadin, W5DID (L), and Werner Haas, DJ5KQ, AMSAT-DL Vice President (R), perform bench checks on one of the Phase 3D's flight electronic modules during recent integration work at the Phase 3D Integration Laboratory in Orlando, Florida. (AMSAT-NA photo by Keith Baker, KB1SF)

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September/October 5

# Phase 3 Ranging System

James Miller G3RUH

[g3ruh@amsat.org](mailto:g3ruh@amsat.org)

**R**anging is the process of measuring the distance from a station to a satellite. Ranges made at different times, and from several locations are used to determine the specifics of an orbit and compute Keplerian elements. Phase 3D, like its predecessors Phase 3A, OSCAR-10 and OSCAR-13 is supported by ground station software and hardware to enable this.

## Why Ranging?

Immediately after launch, Phase 3D's position will be known by everybody because ArianeSpace, ESA and NORAD work together to track it throughout launch and after.

Soon after launch AMSAT will fire the on-board rocket at apogee in order to raise perigee height, and possibly alter the inclination.

Now the problem begins. What are our new orbital elements? We know more or less what they ought to be, and that will do for rough tracking for a day or two. But we really need to re-compute Phase 3D's new elements right away, especially if there has been any problem with the burn.

But why cannot we simply get the new elements from NORAD? The answer is that they won't have them. If we change the satellite's orbit at apogee, Phase 3D will come around the Earth at perigee totally out of position as far as NORAD is concerned. They will fail to acquire Phase 3D with their tracking systems. That is to say, they will lose us. It is up to AMSAT to tell NORAD where we are again.

So it is important that we have a totally independent ranging system for Phase 3D, just as it was for OSCAR-13, OSCAR-10 and Phase 3A before.

## Principles

Ranging is basically the opposite of tracking; if you know a satellite's orbit you calculate its range using a tracking program. The other side of the coin is that if you can measure its range, then you can calculate its orbit (Figure 1).

Obviously you cannot determine the orbit from just one range measurement. You have to make a number of measurements at different times through the orbit, on different orbits, and on orbits when the view varies, such as to the East or

West or, equally, take ranges from different stations scattered around the world.

By collecting maybe a couple of dozen time and range pairs, spread over say five days, one has enough raw data to determine the orbital elements with sufficient accuracy to perform normal tracking again.

## How Ranging?

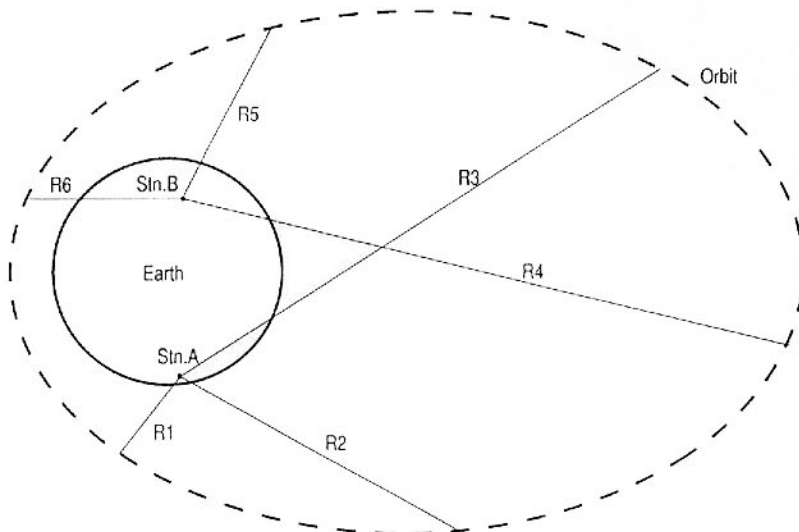
The principle is simple enough. We've all done this at one time or other via a satellite; when you tap the microphone, it sends out a pulse, and a moment later the echo comes back. So if you measure the round-trip time, multiply by the speed of light, that's the round-trip distance; halve it and you've got range (Figure 2).

Notice several things about a single returned pulse. First; only the leading and trailing edges carry timing information. So a longer pulse simply wastes interim power that could perhaps be put to better use. Second, due to the audio channel bandwidth, the shortest practical pulse duration is of order  $1/\text{Bandwidth}$ . Third, the maximum repeat rate is set by the round-trip-time. Send any faster, and the returned pulses overlap, creating ambiguity.

So, though simple, the single pulse approach has limitations. Ideally we would like to send pulses continuously. This would provide a continuous supply of timing edges; so we would be making the most of the available power and channel bandwidth. The overlap ambiguity caused by repeated identical pulses is simply resolved by encoding the bit stream into a sufficiently long repeated message.

Here, for clarity, is a coded sequence 1010011, 7 elements long. You can see how the delayed return sequence can be identified, giving the desired measure of range (Figure 3).

Searching the received sequence for the pattern 1010011 is done by comparing the received stream with a local replica. The replica is *slid* along the received pattern looking for maximum agreement, or correlation (Figure 4).



## Orbit Determination from Six Range Measurements

Figure 1. In principle, 6 range measurements enable computation of six orbital elements, such as the set  $R_x, R_y, R_z, V_x, V_y, V_z$  or  $i, e, m_a, w_p, r_a$  at epoch. In practice many more measurements are made to reduce the effects of noise and poor geometry.

Here you can see that if received data and local replica are aligned, there are 7 matches, and no mismatches, a *score* of 7. If the replica is now slid along one unit of time, the score falls away to near zero.

Plotting the complete graph of score versus alignment shows the peak of 7 corresponding to alignment, and the fall to -1 with misalignment (Figure 5).

The strength of this technique is its tolerance of errors. Suppose one received bit is corrupted; then the score will fall to 5, which is still very distinct from the baseline -1.

Of course the peculiar property of negligible self-correlation when more than one bit out of alignment is no accident. The sequence is one of a family of maximal length pseudo-random number (PRN) sequences, and is exactly  $2^{n-1}$  elements long. Here  $n = 3$ . It can be created by software or hardware from an  $n$ -bit shift register with its output exclusive-ored with one or more intermediate stages and fed back to the register's input. This is called a linear feedback shift register (LFSR), and forms the foundation of many digital communication systems, such as the Global Positioning System, data scrambling, wireless LANs, pagers, spread spectrum systems, radar and as here, ranging.

### Phase 3 System Hardware

We now define the Phase 3 system. The range maximum is of order 50,000 km, a round-trip-time of typically 1/3 s, so the sequence needs to be 1/3s or longer.

The bit rate is chosen to be 400 bps. Now  $400 \times 1/3 = 133$  bits; choosing the power of 2 just larger gives code length of  $2^{8-1} = 255$  bits. This repeats every 0.64 seconds, offering a maximum range of 96,000 km. Coarse resolution, 1 bit, is 375 km, and the 400 bps bit timing can be resolved to about 200 ns (30m).

400 bps is used for two important reasons. First, hardware; something is needed to create uplink bits and decode them from the downlink. It already exists as the Phase 3 command uplink modulator and Phase 3 PSK telemetry downlink demodulator [1]. They run at 400 bps.

Second, the discussion so far assumed that the spacecraft's transponder would be

turned on to return an echo. But that will not necessarily be the case. So how do we get an echo if there's no transponder? Well, the Phase 3 flight computer has an echo mode. The uplinked bit stream is demodulated by the command system, and re-modulated onto the telemetry beacon, so providing a simple digital transponder.

### Ranging Software

Software is needed to generate the 255 bit stream, to receive the decoded stream, compare the two streams, extract their relative phases, display range and diagnostics and save the results to disc.

The screenshot shows a live ranging session via OSCAR-10's transponder. It shows twinkling numbers and four slider bars. The first of these shows that perfect bit detection is being achieved, whilst the second indicates that bit lock has low jitter.

The last two sliders show the relative phase of received signal compared with transmitted signal. It's  $110 + 1411/2500 = 110.5644$  bits or 0.276411 seconds which equates to a range distance of 41,433 km. From this the software has subtracted out the static delay due to hardware of 1446 km to give the displayed actual range of 39987 km.

The raw timing data arrives at 400 measurements/s, and is noisy (jittery) partly due to hardware, but mainly due to radio propagation. This timing information is

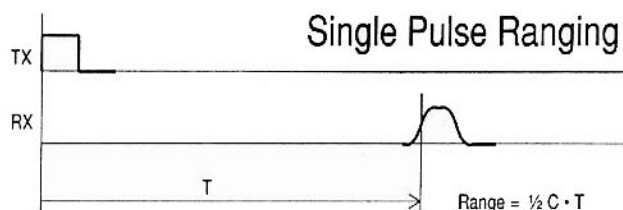


Figure 2. Ranging is based on measuring the round-trip-time of a pulse transmitted to the satellite and received back on the ground. Overlapping returns place a limit on performance.

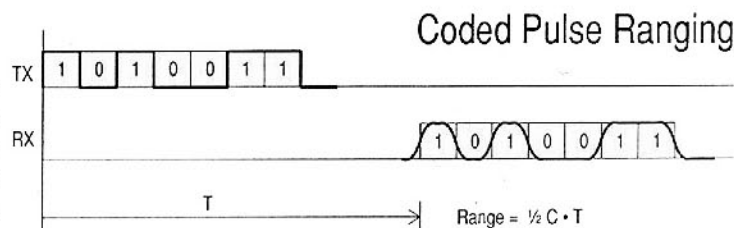


Figure 3. A longer pulse can be broken into a sequence of short pulses. By proper choice of the sequence, overlapping returns can be distinguished, and transmission is continuous.

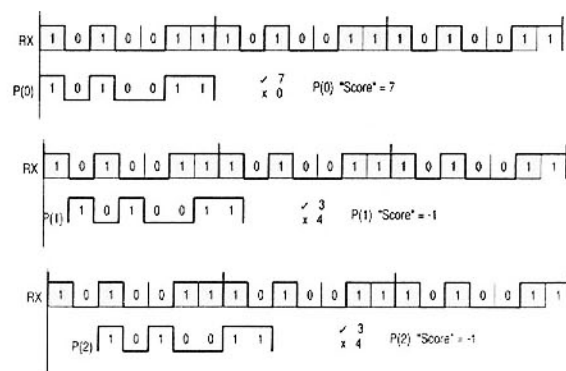


Figure 4. Searching the received sequence for the pattern 1010011 by sliding a local replica along the received signal. This is correlation.

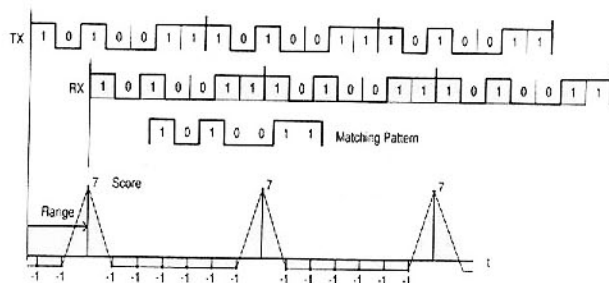


Figure 5. The complete graph of score versus alignment shows peaks of 7 corresponding to alignment, and the fall to -1 with misalignment. An erroneous received bit has negligible effect on the peak.



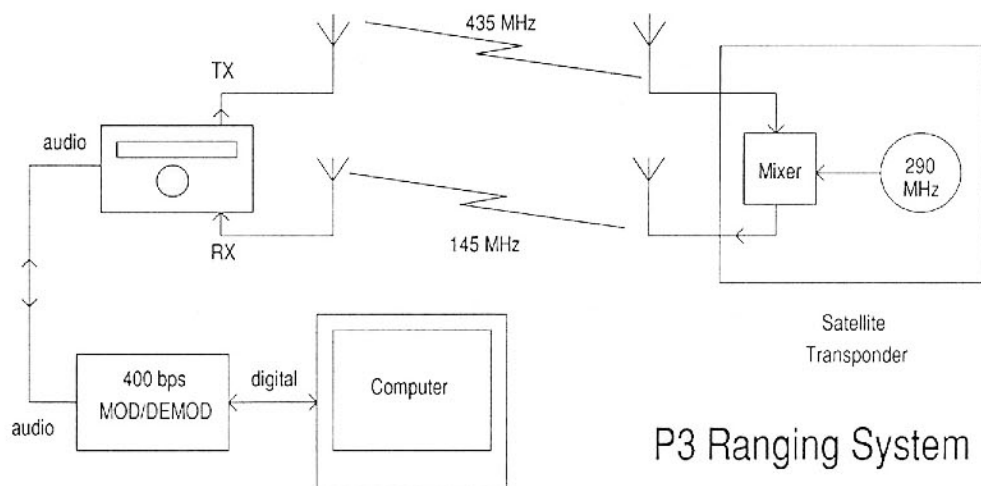


Figure 6. Typical Phase 3 ranging system. Phase 3D will probably use 1.3/2.4 GHz to reduce ionospheric delay effects.

processed by a second order filter which yields range, range-rate and an indication of accuracy. The filter noise equivalent bandwidth is 0.3 Hz.

With a 255 bit sequence, the error rate can be very high. Statistically, a match of at least 170 agreements is certain to indicate that a ranging signal is being received. That implies 85 bit errors, or a 1 in 6 bit error rate (allowing for the differential modulation format). This in turn corresponds to an  $E_b/N_0 = -3$  dB. That's a signal strength some 20x weaker (-13 dB) than the weakest one would be used for normal telemetry. Thus ranging is perfectly possible despite the signal being virtually inaudible. This high

sensitivity is important because during maneuvers the spacecraft's attitude is rarely benign enough to point its antennas at Earth.

### Accuracy

Random errors are introduced by each element in the range path. Typical RMS contributions in meters are:

| Source                         | RMS (m) |
|--------------------------------|---------|
| Modulator+Demodulator+Software | 10      |
| Radio TX + RX (local signals)  | 30      |
| Propagation (strong signals)   | 50      |
| ... (weakest signals)          | 350     |

Static instrumentation errors (biases) are calibrated out, leaving only propagation effects, mainly caused by ionospheric delay variations. Typical zenith errors at 145 MHz are 0.4 km by night, 2 km by day depending on the total integrated electron count over the ray path. These values are doubled at 30° elevation, and typically tripled at the horizon.

Range residuals based on two week's ranging AO-10 (mostly at elevations less than 30°, are typically 5 km RMS. However a plot of fitted range error vs elevation clearly shows the residual errors to be biased.

To some extent this bias can be removed by modeling, leaving worst case residual bias uncertainties of order 0.5 km. However since these errors reduce as  $(1/f)^2$  a better approach would be to reduce them 100-fold by using radio links at L and S-bands. [2,3]

In any event, the range biases are small in the context of the orbit determination program to which range measurements are subsequently delivered.

### Orbit Determination

When a series of range measurements has been collected, they are then processed by the OrbitFit software. This is based on a program originally written by Stefan Eckart, DL2MDL in 1988 for use with Phase 3C/OSCAR-13.

The number-crunching principle used is the same as with all navigation or estimation systems.

You start with a guess at the orbit, and calculate the expected ranges at each of the times you made the measurements. Then you compare the measured ranges with the expected ranges, and the small differences are used to adjust the orbital elements slightly to produce a new set of elements. The process is repeated until the elements don't change any more. Finally the new elements are output in various styles, such as the familiar 2-line format.

### Example

By way of specific example, we consider the first motor burn of OSCAR-13, which took place on 1988 Jun 22 @ 1858 UTC. I have re-run all the

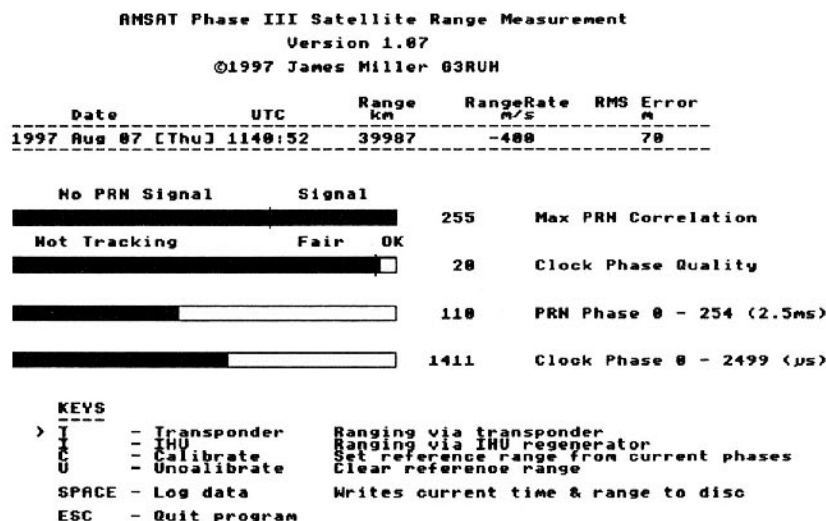


Figure 7. Live screenshot ranging via the OSCAR-10 mode-B transponder. Station is at E0.0589°, N52.2077°.

|                  | (1)<br>Post Launch<br>NORAD | (2)<br>Post Burn<br>Predicted | (3)<br>Post Burn<br>After Ranging | (4)<br>Post Burn<br>NORAD |
|------------------|-----------------------------|-------------------------------|-----------------------------------|---------------------------|
| Epoch time:      | 88171.24031                 | 88174.78919                   | 88174.78919                       | 88174.78919               |
| Inclination:     | 9.9753                      | 13.796394                     | 14.1441                           | 14.3010                   |
| RA of node:      | 243.3977                    | 243.0702                      | 242.8089                          | 243.2583                  |
| Eccentricity:    | 0.7303521                   | 0.7028709                     | 0.7014365                         | 0.7012999                 |
| Arg of perigee:  | 181.1498                    | 183.1604                      | 183.4078                          | 183.0315                  |
| Mean anomaly:    | 174.981788                  | 178.80542                     | 178.1484                          | 178.1585                  |
| Mean motion:     | 2.2581620                   | 2.2050733                     | 2.20044346                        | 2.20041400                |
| Epoch rev:       | 8                           | 16                            | 16                                | 16                        |
| Semi major axis: | 24546.726                   | 24938.175                     | 24973.083                         | 24973.177                 |

Table 1. A Comparison of AO-13 Keplerian elements.

calculations, done by Eckart and myself at the time, to illustrate the process.

The Table 1 shows four sets of Keplerian elements. The first set (1) were provided by NORAD soon after launch. The planned first motor burn of  $\Delta V = 136$  m/s along direction Alon 75 Alat -55, Orbit 16 @ MA 180 was added to it to generate a predicted element set for post-burn (2).

After the burn had taken place, command stations in Germany, Australia and New Zealand performed a total of 20 range measurements over the next five days. These ranges were then run through the OrbitFit program which generated the third set of data (3). This set was then passed to NORAD and they immediately acquired AO-13 and provided a final set of data (4) which, for this table, has been worked backwards to match the epoch time of the third set.

Comparing the set calculated by AMSAT Ranging (3), and the set (4) subsequently obtained from NORAD, shows excellent agreement.

Comparing Range and velocities versus time using set (1) and set (4) shows that they intersect at Day 1988/174 T=1857 UTC. The difference in velocities at that moment is a  $\Delta V$  of 150 m/s along a direction Alon=75.1, Alat=-56.2. That attitude compares well with the pre-burn attitude estimate made using the on-board Sun and Earth sensors. The increased  $\Delta V$  was due to programming a burn of longer duration than advertised. This information was also used to calibrate the motor thrust.

### Conclusion

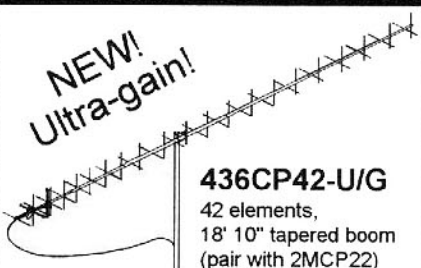
Amateur radio ranging has a long pedigree. Many years ago Karl Meinzer developed a ranging system for the early ARTOB balloons in Germany. It was successfully used to find the balloons when they came down. Much easier and faster than using fox hunting methods. Reference [4] describes ranging OSCAR-6 in 1973 using Slow-Scan TV Equipment. And of course it was used in a similar embodiment to that described in this article during the post launch phase of Oscar-13 in 1988. The current system uses the pre-existing uplink/downlink hardware, and the software runs on an Acorn Risc Computer [5] via the parallel printer port. It has been exercised via OSCAR-20 and OSCAR-10 and works perfectly. It now awaits its calling by Phase 3D.

### References

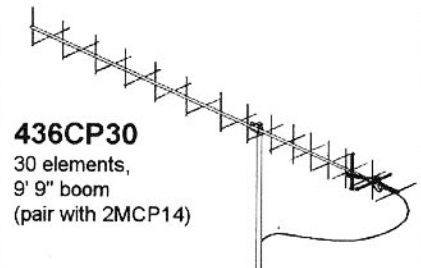
1. Phase 3 400 bps PSK Telemetry Demodulator. PCB available from the author at 3 Benny's Way, Coton, Cambridge CB3 7PS, England, and other sources. E-mail: g3ruh@amsat.org
2. Spilker, J.J., GPS Signal Structure and Performance Characteristics, *Journal of the Institute of Navigation (USA)*, Vol. 25 No. 2, 1978.
3. Spilker, J.J., *Digital Communications by Satellite*, Prentice Hall, 1977
4. Meinzer, K., Range Measurements with OSCAR-6, *QST* May 1973.
5. Acorn Risc Computer: <http://www.acorn.co.uk/acorn/products/strongarm/> ■

## M<sup>2</sup> YOUR SATELLITE ANTENNA SOURCE

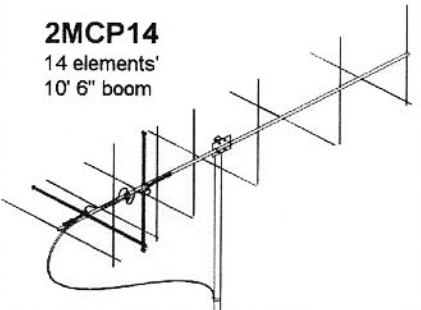
NEW!  
Ultra-gain!



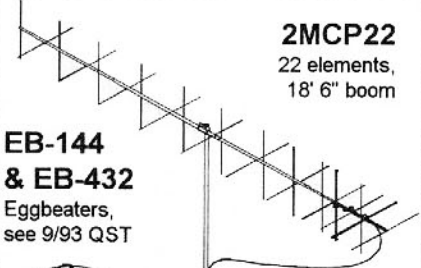
**436CP42-U/G**  
42 elements,  
18' 10" tapered boom  
(pair with 2MCP22)



**436CP30**  
30 elements,  
9' 9" boom  
(pair with 2MCP14)

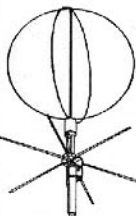


**2MCP14**  
14 elements  
10' 6" boom



**2MCP22**  
22 elements,  
18' 6" boom

**EB-144  
& EB-432**  
Eggbeaters,  
see 9/93 QST



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# VEC2TLE Version 9648 — New and Improved

Ken Ernandes, N2WWD

[n2wwd@amsat.org](mailto:n2wwd@amsat.org)

The Vector to Two-Line Elements (VEC2TLE) software is used to compute Keplerian elements for the Space Shuttle and for new Amateur Radio Satellites. The features added to VEC2TLE version 9648 make it easier to use, mainly because they reduce operator workload. The most important upgrades are (1) the software's ability to automatically extract state vectors from ordinary text files and (2) its ability to update AMSAT and Two-Line Elements (TLEs) directly in any Keplerian element text file. With a one-time setup, Space Shuttle or new satellite Keplerian elements can be updated *quickly and easily*.

## New Features

VEC2TLE's new features are summarized below. Each of these improvements eliminate manual *copy and paste* editing steps required with previous versions. Automating these processes not only saves time, but it also prevents the errors that often occur with manual editing. The new features provide the quickest and easiest way to update your Keplerian element files.

**(1) Automatic Vector Read-** VEC2TLE now automatically finds formatted state vectors embedded in ordinary text files. In the past, the user had to find the vector, copy it [eliminating all of the surrounding information], and paste it in a text file for VEC2TLE to read. Now VEC2TLE searches the file, finds the vector, and reads it in all in one step.

**(2) Automatic Two-Line Element Updates** - VEC2TLE can now *replace* existing Keplerian TLEs in any designated text file. In the past, the software *appended* the new TLE to the end of the specified Keplerian element file. In many cases the user had to manually delete the old TLE to ensure the tracking software would read the new TLE. Since most users do not want to keep the old Keplerian elements, the default option is to *replace* the old TLEs with the new ones. The *append* option is still available as is the option not to output the TLE data at all.

**(3) Automatic AMSAT Keplerian Element Updates** - VEC2TLE can now replace existing AMSAT-formatted Keplerian elements in any text file. Previously released versions of VEC2TLE did not have the option to create AMSAT-formatted Keplerian elements. The current version *replaces* the old AMSAT Keps with the new data by default. As with the TLE Keps, there are also options to *append* or not to output the AMSAT Keps at all.

If VEC2TLE is configured to replace a particular satellite's Keps and those elements do not exist in the output file, the program will append the new Keps to the end of the file.

## Setup Process

The *VEC2TLE User Instructions* provide detailed step-by-step procedures for

configuring the software and computing Keplerian elements. This section gives a quick overview for setting up the new features in VEC2TLE.

There are two distinct processes for configuring VEC2TLE: selecting the output files and setting the data output modes (Replace, Append, Disable Output). These procedures are illustrated in the following:

**Selecting Output Files** - The user may specify output files for TLEs, AMSAT Keps, and State Vectors. These are usually different files, but the software can also update all data types in a single file. The example will demonstrate selecting a TLE file; the procedure is essentially the same for selecting AMSAT Keps and State Vector files.

You can choose the Two-Line Element filename by selecting *TLE Output File* from the *File* menu as illustrated in Figure 1.

This menu selection opens a dialog box as illustrated in Figure 2. From this dialog box you specify the name of the output TLE file.

The easiest way to choose a file is by using the mouse and selecting the file from the scrollable list in the middle of the dialog box. The dialog box displays files with a \*.TLE extension from VEC2TLE's directory. You can also use the mouse to change the directory within the list box. You can change the TLE filename, directory, or the default file extension by keyboard entry to the pull-down text field above the list box. The pull-down text field saves a history of manual keyboard entries.

**Setting Data Output Mode** - These data output modes (Replace, Append, or Disable) provide individual data output controls for the TLEs, AMSAT Keplerian Elements, and State Vectors. You access this option by selecting *Data Output Options...* from the *File* menu as illustrated in Figure 3.

Selecting *Data Output Options...* from the *File* menu will open the dialog box illustrated in Figure 4. From this dialog box, you set the output modes for the TLEs, AMSAT Keplerian Elements, and State Vectors.

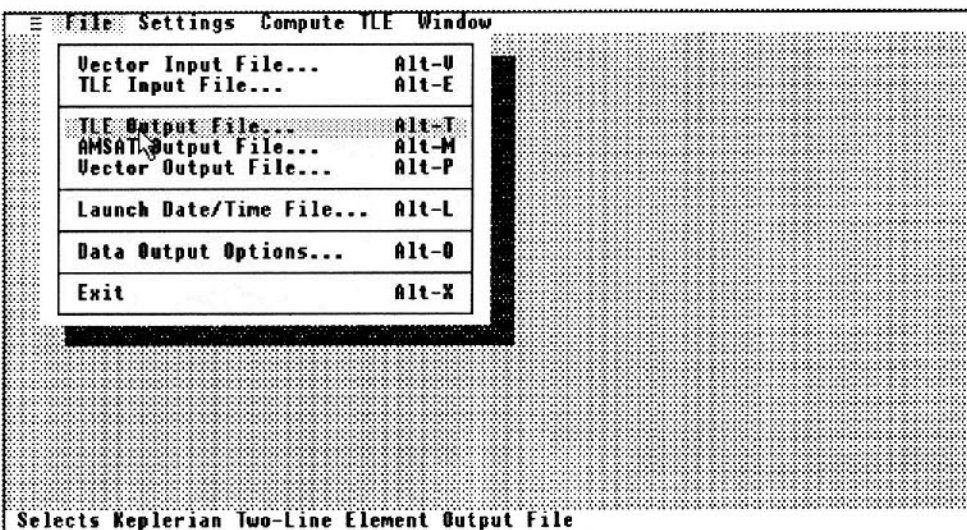


Figure 1. Selecting a TLE Output File



Notice that you set the options independently for each output data type. The output options were implemented this way since most users only care about one or two of the output data formats. This implementation provides the flexibility to tailor the output to each user's needs.

The program automatically saves the settings made using the above procedures in its configuration file. VEC2TLE uses these settings thereafter, unless you re-accomplish one or both setup processes. Therefore, these procedures are *one time settings* unless your output requirements change.

### Update Process

VEC2TLE updates Keplerian elements by reading a file containing a formatted State Vector. The easiest way to do this is by selecting *Read Vector File...* from the *Compute TLE* menu as illustrated in Figure 5. This selection opens a Vector Input dialog box similar to Figure 2. The main difference between the dialog boxes is that the default vector file extension is now \*.VIF (for Vector Input File).

Once you select a file containing a State Vector, VEC2TLE automatically searches through the file for the vector. Once it finds a vector, it opens a dialog box containing the vector data. This dialog box allows you to edit any of the parameters. *Advanced users* may edit some parameters in this dialog box such as the element number, revolution number, or drag. Most users simply dismiss this dialog box (with the "OK" button), letting VEC2TLE compute the corresponding Keplerian Elements. The program then writes the orbital data to your output files as specified by VEC2TLE's configuration file (and as set in Figure 4). VEC2TLE also opens a window containing a summary of the input State Vector and output Keplerian Elements as illustrated in Figure 6.

If the input file contains more than one State Vector, you may repeat the *Read Vector File* procedure (as illustrated in Figure 5) until you process all of the vectors.

### Discussion

VEC2TLE was written primarily to compute Space Shuttle Keplerian elements from NASA State Vectors. The Space Shuttle Keplerian elements tend to become *stale* quickly because of frequent orbital changes.

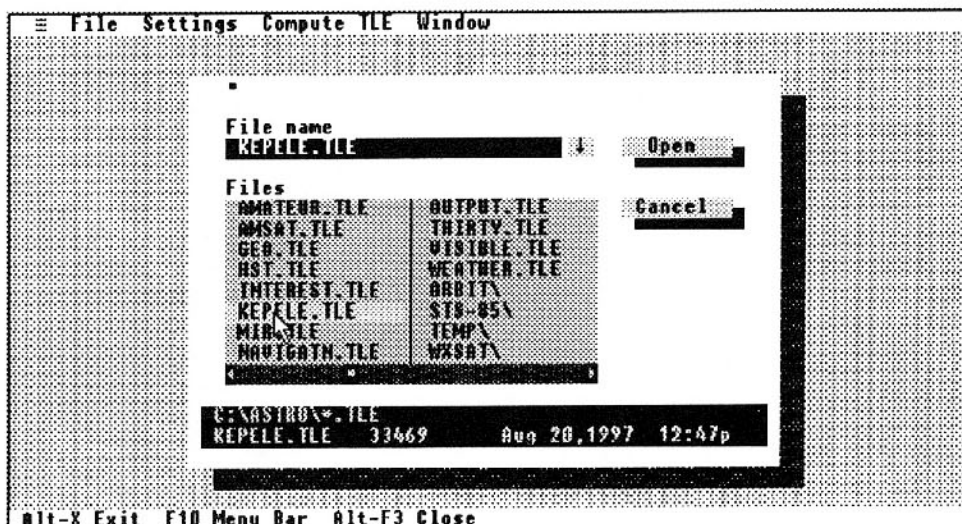


Figure 2., Specifying the TLE Output File via the Dialog Box

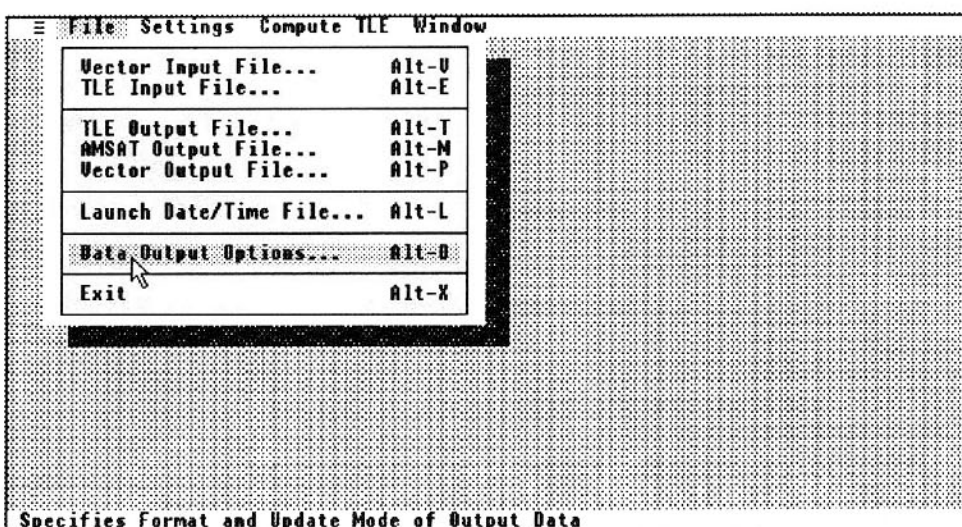


Figure 3., Selecting Data Output Options

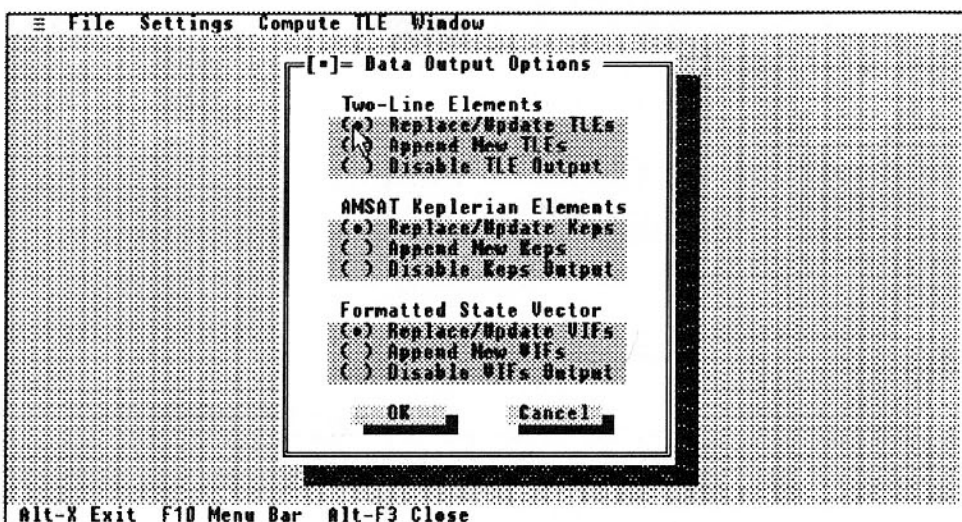


Figure 4., Setting Data Output Options

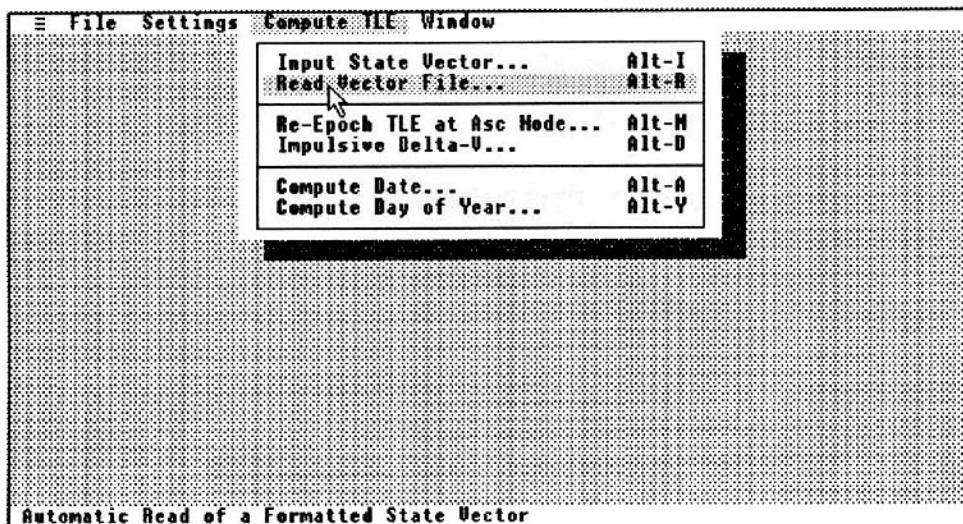


Figure 5., Reading a State Vector File

These orbital changes vary in magnitude and result from, among other things, Orbital Maneuvering System (OMS) thruster firings, Reaction Control System thruster firings, satellite deployments and retrievals, and waste water dumps. A more complete discussion of orbital changes is available in reference 1.

The Internet has made obtaining NASA State Vectors and computing and distributing the corresponding Keplerian elements a very efficient process. Updates to the AMSAT Keplerian element are usually posted within an hour following a major orbital change, often leading the release of corresponding Space Command Keplerian elements by several hours. I have received numerous reports crediting the difference between success and failure of a SAREX contact to the availability of post orbital

change Keplerian elements on the AMSAT Web page.

The desire for a timely Keplerian element update mechanism prompted Alan Cunningham, KD4ESE of NASA Spacelink to sponsor the Space Transportation System Two-Line Elements (STSTLE) mailing list. This is an Internet mailing list whose primary purpose is distributing current Space Shuttle Keplerian elements to NASA payload operations centers, educational institutions, and other individuals interested in receiving this data. Coordinated updates are made by three volunteer contributors: Ken Ernandes, N2WWD, Dave Ransom (STSORBIT PLUS Author), and Dave Cottle (Sydney, Australia). The vector source data for these updates comes primarily from Dave Simonson at the DOD C-Band Radar Network, Cape Canaveral.

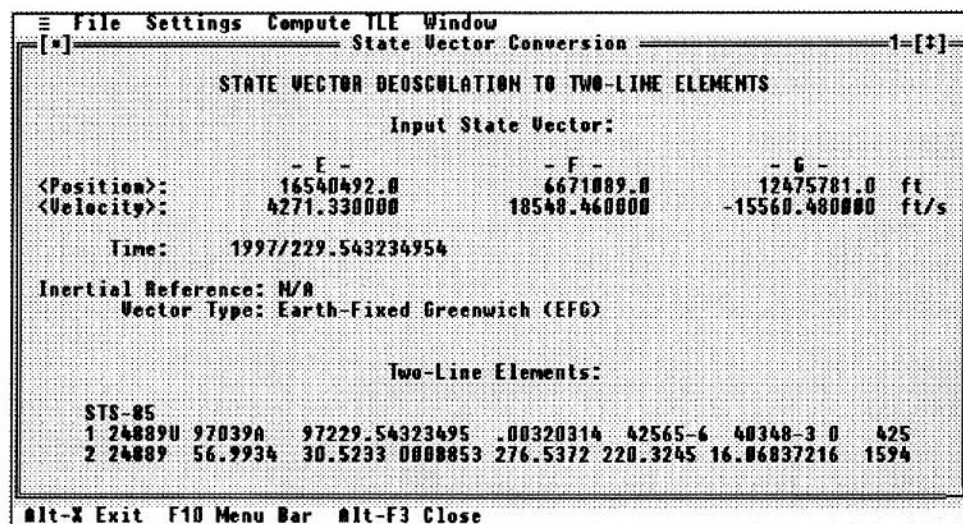


Figure 6., Keplerian Elements Computed from the State Vector

In addition to the Space Shuttle support, VEC2TLE has been a very useful tool for estimating Keplerian elements for new Amateur Radio satellites. The success is due, in part, to the program's ability to process either UTC-referenced or [time-independent] Mission Elapsed Time (MET) referenced State Vectors.

VEC2TLE's first *operational* amateur radio satellite application was computing RS-15's Keplerian elements (see references 2 and 3). Because of complications associated with the launch booster's post-satellite-deployment upper stage explosion, VEC2TLE provided the only accurate Keplerian elements for the first few weeks following the RS-15 launch.

VEC2TLE also computed Keplerian elements that allowed North American stations to monitor FO-29's beacon on its first revolution following launch. Because of my request, the Japanese Space Agency and AMSAT-JA provided a nominal (planned) JAS-2 booster deployment State Vector. (JAS-2 was subsequently re-named FO-29.) I converted the nominal State Vector to the time-independent, Earth-fixed coordinates. This VEC2TLE-formatted vector was available to interested amateurs. AMSAT-JA posted timely status updates via the Internet, including immediate launch time confirmation. Once the launch time was known, VEC2TLE computed the corresponding Keplerian elements. These Keplerian elements were, in-turn, immediately distributed to interested amateurs, via the AMSAT-BB Internet mailing list.

VEC2TLE also produced preliminary Keplerian elements for both the MO-30 and the RS-16 satellites. Reference 4 provides VEC2TLE's preliminary pre-launch estimates of the Phase 3D Keplerian elements.

### Shuttle Data Update Sources

The AMSAT Web page typically has three to four orbital updates per day during Space Shuttle missions. The data is in three separate files containing: the vector, the AMSAT Keplerian elements, and the Two-Line Keplerian elements. The Uniform Resource Locator (URL) for the AMSAT Shuttle Orbital Data is:

<http://www.amsat.org/amsat/sarex/orbit.html>



NASA Spacelink sponsors the STSTLE mailing list that also provides Space Shuttle orbital updates. To subscribe to this service, send an E-Mail message with the text: **subscribe STSTLE Your Name** to the following Internet address:

**listproc@spacelink.nasa.gov**

The mailing list manager will use your return E-Mail address as the destination for the E-Mail updates. You may subscribe to the STSTLE mailing list, but be cautioned that updates occur three or more times per day for both SAREX and non-SAREX Space Shuttle missions. If this is an undesirable number of updates, the AMSAT Web page would be a better choice (since you will only get updates when you download them).

A third source of Shuttle orbital data is my personal [Orbitessera] Web page. This page has a link to a recent, if not the latest STSTLE message. Orbitessera is a backup data source when the AMSAT Web page is busy (as is sometimes the case during Shuttle missions). The URL for the Orbitessera Web page is:

**<http://www.mindspring.com/~n2wwd>**

The Orbitessera Web page also provides a table of information specific to the current (or next) Space Shuttle mission.

NASA Orbital Information Group (OIG) Reports and Information Dissemination (RAID) Remote Bulletin Board Service (RBBS) posts hourly state vector updates during Space Shuttle missions. While VEC2TLE cannot read this vector format directly, Curtis Haase has written a program called VEC2VIF that does the necessary formatting. VECTLE distribution files and diskettes include the VEC2VIF software.

NASA OIG RAID RBBS is accessible by Internet Telnet (**[oig1.gsfc.nasa.gov](http://oig1.gsfc.nasa.gov)**) with an entry user ID of "oig" and a corresponding "goddard1" password. From there, you can log-on to an individual user account and download vectors, Keplerian elements, and other data. NASA OIG RAID is also accessible by direct telephone link at (301) 805-3251 or (301) 805-3154.

### VEC2TLE Availability

VEC2TLE is available from a variety of sources, including direct purchase from AMSAT. You may alternatively download the software from the AMSAT Shuttle

Orbital Data Web page and the Orbitessera Web page. While the program is licensed as *shareware*, there is no registration fee for use in a hobby such as Amateur Radio. Copies purchased directly from AMSAT include a license for *professional use*. Furthermore, the copies purchased from AMSAT also include V2KEP, a command-line version of VEC2TLE suitable for use in batch files. If you want the command-line V2KEP software, I encourage direct purchase from AMSAT.

VEC2TLE is an MS-DOS based program that runs well on PC platforms using MS-DOS or MS Windows. I have also received several favorable reports of the software running on Apple Macintosh and Sun Workstation computers (using DOS emulation software). Those who are not equipped to run DOS programs may still manually copy-and-paste the Keplerian elements contained in the Space Shuttle orbital update data messages.

### Summary

VEC2TLE version 9648 provides quick and easy Keplerian element updates for the Space Shuttle and new amateur satellites. This version reduces operator workload by

eliminating most of the manual *copy and paste* operations required with previous releases. With the latest upgrades, the user can now read any text file containing a formatted state vector and automatically update any Keplerian element text file.

### References

- [1] Vector to Two-Line Elements (VEC2TLE) Orbit Computation Software, Ken Erlandes, N2WWD, *The AMSAT Journal*, Volume 17, No. 2, March/April 1994.
- [2] Early Reports on RS-15, Bob DeVarney, WE1U, *The AMSAT Journal*, Volume 18, No. 1, January/February 1995.
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# Introduction to Amateur SETI

Dr. H. Paul Shuch, N6TX, Executive Director  
The SETI League, Inc. ([n6tx@setileague.org](mailto:n6tx@setileague.org))

The notion of humankind's uniqueness in the universe had been challenged by philosophers since before Copernican times. Nevertheless, it is only within the twentieth century that the existence of other technologically advanced civilizations in space has become a possibility accepted within the scientific establishment. Far more recently still has the feasibility of detecting such other civilizations entered mainstream thinking. Today, the search for evidence of other inhabited worlds is in full swing, thanks in part to the interest and expertise of the world's Amateur Radio operators, radio astronomers, and microwave experimenters. This Introduction tells you how you can join the search.

The first scientific paper seriously contemplating surveying nearby stars for intelligently directed microwave signals was titled, boldly enough, *Searching for Interstellar Communications*. It was written by Cornell physics professors Giuseppe Cocconi and Philip Morrison, and published in the British journal *Nature* in 1959. Unbeknownst to Morrison and Cocconi, as they were writing their pivotal paper, a young radio astronomer was preparing to perform the very experiment which they were describing. That scientist, Dr. Frank Drake, launched his Project Ozma search from the National Radio Astronomy Observatory (NRAO) facility at Green Bank, WV in 1960, ushering in the era of modern SETI.

Why do we suppose other civilizations might be detectable by their microwave radiation, and how will we know where to look for them? For that matter, why don't we simply look with our eyes? One problem is that stars typically outshine their unseen companions by about a billion to one.

Seeking a planet orbiting another star is a little like trying to see a firefly perched on the rim of a searchlight. This is why the detection of extra-solar planets was not even possible until the current decade, and required the development of rather elaborate instrumentation. But at certain times, on certain frequencies, our Earth outshines the Sun a million to one.

The Earth is currently surrounded by a sphere of microwave radiation roughly fifty light years in radius, which is readily detectable over interstellar distances utilizing technology such as is today available to even amateur radio astronomers. This radiation, emanating primarily from our planet's UHF TV transmitters and long range search radars, would mark our planet as inhabited to any similar technological society within fifty light years. Within that range are found hundreds of stars, tens of which are sufficiently sun-like to probably host one or more habitable planets.

The distance over which we are detectable is limited only by the time since we first began transmitting these sufficiently strong signals in the appropriate frequency range. Fifty years from now, we will be detectable out to 100 light years distance. At that point our signals will have engulfed thousands of stars, including hundreds of potential life sites. With every successive doubling of elapsed time (out to 1,000 years or so), the number of civilizations which our radiation signature can potentially reach goes up by a factor of eight. Sooner or later, our signals may well reach distant ears.

SETI hypothesizes that other technological civilizations are similarly surrounded by a detectable sphere of microwave radiation, the radius of which will be limited only by how long such civilizations have possessed sufficiently advanced radio technology. We depend upon our ability to intercept and recognize (though not necessarily decode) such a radiation signature, to provide proof of the existence of other intelligent civilizations.

The problem with seeking incidental radiation is that the unknown factors exceed the known. We can only guess as to where physically to point our antennas, when to listen, and on what frequency. Interesting signals, after all, could be coming from any direction in the 4 pi steradians of space surrounding us. Other civilizations might well have harnessed any segment of the electromagnetic spectrum, and could be transmitting now, in the distant future, or in the deep past. Or maybe not at all. We just don't know.

The time dimension is resolved by starting to look now, and continuing until we detect something noteworthy. Given a great enough number of coordinated stations, effectively looking in all directions at once, we might resolve the pointing uncertainty. And we can narrow the search space in the frequency dimension by recognizing that particular range of frequencies which is least attenuated by planetary atmospheres and the interstellar medium. This, however, leaves us with most of the microwave spectrum, and much of the optical, as our likely range of frequencies.

Since there are no *wrong* frequencies to search, SETI has attempted to scan them all. One person's guess is as good as another's, so any frequency for which you can assemble a sufficiently sensitive telescope is fair game. Radio astronomers have long explored protected portions of the 406 MHz, 610 MHz, 1.42 GHz and 10.6 GHz bands, and I can think of no good reason why not to pursue the SETI dream in those spectral regions as well. And the world's radio amateurs have the capacity to scan a good many additional VHF, UHF and microwave frequencies, any of which may bear cosmic fruit.

The foregoing, however, applies only to the problem of scanning for incidental radiation from the distant civilization. What if another intelligent race were making a deliberate, concerted attempt to signal its presence to its interstellar neighbors? Is there a particular frequency, or range of frequencies, which would be self-evident to the receiving civilization? Can we narrow the search space?

Cocconi and Morrison thought so when they published their 1959 *Nature* article. They reasoned that 1420.40575 MHz, a natural emission frequency of neutral hydrogen atoms, was a good place to start looking for intelligently directed interstellar beacons. This frequency, which falls in the quietest part of the radio spectrum, is marked for all to see, by Nature herself. Everywhere you point a radio telescope, from anywhere in the Universe, you can hear this radiation, emanating from the one hydrogen atom which occupies each cubic centimeter or so of interstellar

space. There is nothing geocentric about hydrogen radiation. Perhaps, it can be reasoned, selecting it for interstellar communication is a mark of intelligence, in and of itself.

Drake had arrived at this same conclusion independently of Morrison and Cocconi, and indeed set out to monitor a narrow band of frequencies encompassing the neutral hydrogen line (also known as H1) during his Project Ozma search. Today, nearly four decades later, the hydrogen line region still looks like a good bet to many SETI professionals. But the search need not stop at hydrogen.

Just a little ways higher up the microwave spectrum, around 1660 MHz, is another interesting spectral line, this one being the mark of radiation from interstellar hydroxyl (OH to the chemist). The late Dr. Bernard M. Oliver, who headed the now defunct NASA SETI effort, pointed out in the Cyclops Study (NASA's monumental 1971 research effort documenting the greatest radio telescope never built) that these two clearly discernible signposts occupy a prominent position in the quietest part of the sky. There are no other distinct radiation lines between them. And taken together, hydrogen and hydroxyl represent the disassociation products of water, the one solvent critical to all life processes known to us. This hydrogen-plus-hydroxyl-makes-water line of reasoning led Oliver and others to dub the region between their radiation lines the Water Hole, and to suggest that this may well be the natural interstellar communications band, defined for us all by Nature herself. "Where shall we meet other lifeforms?" asked Barney poetically. "At the water hole, where species have always gathered."

Fortunately for SETI, much classical radio astronomy research already goes on at the hydrogen line, the hydroxyl line, and the spectrum in between. Equipment for this frequency region is abundantly available, and much of it can be readily adapted to SETI use. From radio observatories at Ohio State and Harvard Universities in the US, from the Arecibo Observatory in Puerto Rico, from dishes in Argentina and Russia and Australia and Germany, cosmic anglers continue to cast their radio nets across the Water Hole, hoping to snag a big fish. There have been a few nibbles already. And some

of those have been detected by Radio Amateurs.

There are indeed other likely *magic frequencies* which are being scanned for signals of possible intelligent extra-terrestrial origin, and once again, one person's guess is as valid as another's. Nevertheless, since many of the world's radio telescopes are already scanning the hydrogen line and its environs for natural astrophysical phenomena, it's a small step to make their receivers search for artificial signals as well. This is precisely what Drake's Project Ozma attempted to do in 1960.

Project Ozma must be considered the very first SETI study. It surveyed two nearby sun-like stars (Tau Ceti and Epsilon Eridani), for just a few weeks, at just one frequency, and detected no extra-terrestrial intelligent signals. Nevertheless, Ozma served as a model for dozens of later SETI endeavors, including The SETI League's own Project Argus sky survey.

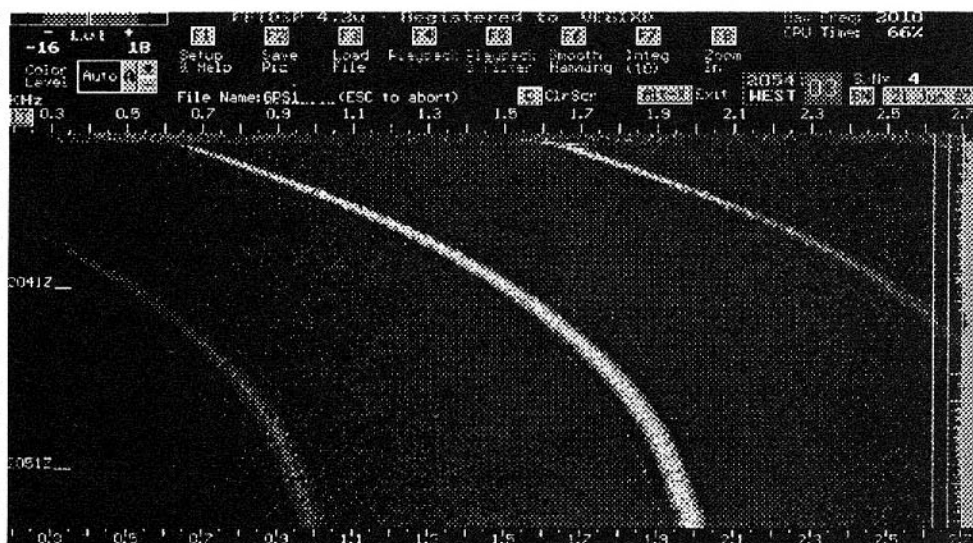
The world's first professional SETI meeting was convened by Frank Drake at Green Bank in 1961. As the agenda for that conference, Drake drafted an equation for estimating the number of possible communicative technologies in the cosmos. He scribbled it on the blackboard, thus:

$$N = R^* \cdot f_p \cdot f_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

I do not intend to analyze the Drake Equation here, or to speculate on assigning values to its various factors. Whole books have already been devoted to that study. Suffice it to say that Drake's Equation is the primary probabilistic tool whereby SETI scientists assess their prospects of success. It is engraved on a plaque which graces the very wall at Green Bank where once hung the blackboard on which it first appeared. Drake himself considers his equation a way of quantifying our ignorance. Its seven factors encompass cosmology, planetology, atmospheric science, evolutionary biology, psychology, technology, and sociology. Thus SETI is possibly the most interdisciplinary of the sciences.

In the nearly four decades intervening, on the order of fifty different SETI projects have been conducted around the world, with frequency coverage extending throughout the microwave, millimeter-wave, and optical spectra. These searches have been attempted by government agencies, educational institutions, non-profit scientific organizations, and, more recently, by amateurs.

Although no definitive proof of



**Global Positioning Satellite interference on 1575.7820 MHz USB, detected by SETI League member Ian Drummond, VE6IXD, on 21 June 1997. Ian says, "I assume it is a navigation signal and not the one we have been waiting for!" The Doppler pattern evident in this image is characteristic of mid-orbit satellites. The appearance of this signal should help to dispel the myth that pseudo-random-noise coded spread-spectrum signals are indistinguishable from the background noise! In fact, though difficult to decode without the proper key, the presence of these signals is quite evident. Should other civilizations be using spread spectrum communications, our chances of detecting them are not necessarily diminished. (VE6IXD image)**



extra-terrestrial intelligence has yet been received, SETI has achieved scores of tantalizing hints that such signals might indeed exist. Many candidate signals have been attributed to terrestrial, aircraft and satellite interference, others to equipment malfunction and natural astrophysical phenomena, but about one candidate signal per year defies explanation. Since these signals have failed to repeat and have eluded our attempts at verification, we can draw no conclusion save that there is much to be learned about the universe we inhabit.

It's important to remember that SETI was emerging at a time when in the US, nationalism ruled science. Our government had set out in the late 1980's to become the world leader in subatomic particle research, and to do so, Congress had authorized funding for a multi-billion dollar Superconducting Supercollider. Construction was actually begun near Waxahachie, TX, and some hundreds of millions of dollars expended, before more mundane projects (such as feeding and clothing the populace) began to vie for attention.

At about this time, NASA had a modestly funded but technologically

ambitions SETI project under way from headquarters at the Ames Research Center, Mountain View, CA. Budgeted at \$12.6 million annually (about 5 cents per American per year), NASA SETI kicked off on October 12, 1992, the 500<sup>th</sup> anniversary of Columbus' first voyage of discovery. The plan was to conduct a ten-year search.

Just one year later, in October of 1993, Congress pulled the plug on the Supercollider. Particle physics was deemed wasteful of our limited resources. And if particle physics was wasteful, the reasoning went, SETI was all the more so. We had been searching for a full year, argued Senator Richard Bryan (R - Nev.), and not one little green man had yet walked up and said 'Take me to your leader.' Which proved they do not exist.

In a single sweep of the pen, our elected leaders opted to cancel the Superconducting Supercollider, and NASA SETI as well. This makes good economic sense to some, since the cancellation of NASA SETI alone did indeed reduce the federal deficit . . . by all of 0.0006 percent!

Now enter Richard Factor, a New Jersey Radio Amateur (WA2IKL), science buff,

and industrialist of more than modest means. Factor's company, Eventide Inc., was a leader in broadcast and studio electronics, aircraft navigation equipment, and a number of other high-tech products. For years Factor had toyed with the notion of building up his own amateur SETI station, and scanning the stars for signs of life. With the termination of NASA SETI, his resolve intensified.

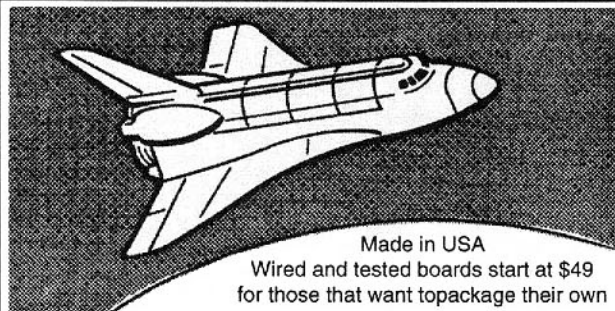
"I got really mad when Congress killed SETI and the Superconducting Supercollider in the same year," says Factor. The Supercollider, with a price tag of \$10 billion, was beyond his help. But SETI, he decided, could be salvaged. So he founded a non-profit, membership-supported educational and scientific corporation to privatize SETI. And he hired me, then an electronics professor in the Pennsylvania State University system, to run it. The SETI League was not my first taste of non-profit science, but it quickly became apparent that it would be the most challenging. For starters, it fell to me to decide exactly what role a citizen's group could play in resurrecting some component of the late NASA effort.

NASA SETI had been comprised of two distinct but complimentary research elements: a targeted search of nearby sun-like stars, and an all-sky survey for interesting signals of unknown origin. The former, which involves aiming powerful radio telescopes at likely candidate stars for long periods of time, is well suited to large, steerable dishes with their narrow beamwidths and high sensitivities. If we guess right as to which stars constitute likely candidates, the thinking goes, the targeted search will provide us with the greatest likelihood of immediate success. But since only a limited number of relatively nearby candidate stars is known to us, concentrating our search in their direction may cause us to miss an equally good star of which we happen to be unaware.

An all-sky survey, on the other hand, makes no a priori assumptions as to the most likely direction to explore. The sky survey attempts to sweep out the entire sky which can be seen from a given location. No antenna tracking is required, since it is the entire sky, rather than individual stars, which we seek to scan. While targeted search antennas must be constantly moved,

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sky survey radio telescopes are operated in meridian transit, or drift-scan mode, in which the experimenter never needs to aim the antennas. Rather, it is the Earth's rotation which turns them.

Shortly after its demise, NASA's late targeted search was resurrected by the non-profit California-based SETI Institute. This scientific organization had been the institutional home of many key players in NASA SETI, and they set about securing private sponsorship. Their aim was to utilize the same receivers and computer analysis tools they had designed for NASA, in a private search of the thousand nearest sun-like stars. They called their search Project Phoenix, having risen from the ashes of the late NASA SETI program.

Their success in this endeavor has been an inspiration to all who advocate the privatization of science. If they are as effective at science as they are at fundraising, the SETI Institute cannot miss. Project Phoenix employs some of the world's finest radio telescopes, aiming them sequentially at promising targets from a catalog of nearby sun-like stars. But since large antennas have quite narrow beamwidth, they see only a small portion of the sky at a given time. To sweep out the whole sky with such large antennas would consume inordinate amounts of time. A sky survey effort, as opposed to a targeted search, would be best performed with antennas of moderate size.

Smaller antennas can see more sky within their beam patterns, but have correspondingly less gain, thus more limited range. We achieve reasonable sensitivities through digital signal processing, the application of powerful computers to sift through the cosmic static for patterns which Nature cannot produce. But the antennas need to remain fixed on their targets for a relatively long time period, as the computers average out the background noise. With large antennas, this would require active tracking as the area of interest appears to drift east to west across the sky.

Fortunately, when used in meridian transit mode, small antennas, with their relatively wide beamwidths, provide us with far greater signal acquisition time than do the larger antennas typically used for targeted searches.

The SETI League was actively attracting radio amateurs and microwave experimenters around the world, with the promise of some undefined great SETI project. And the sky survey approach seemed ideally suited to the community of Amateur Radio astronomers desiring to pursue SETI. So that is the aspect of SETI which Factor and his fledgling organization chose to pursue. A grass-roots effort ultimately involving thousands of Amateur Radio telescopes worldwide, the SETI League's Project Argus sky survey was initiated in April of 1996, with only five active stations. Within a year and a half, the network had grown to over 50 listening posts, and the League to 1,000 members in 33 countries on six continents. When fully deployed early in the next century, it is expected that Project Argus will provide (for the first time ever) real-time full-sky coverage, its thousands of antennas collectively looking in all directions at once, across all four pi steradians of space and time.

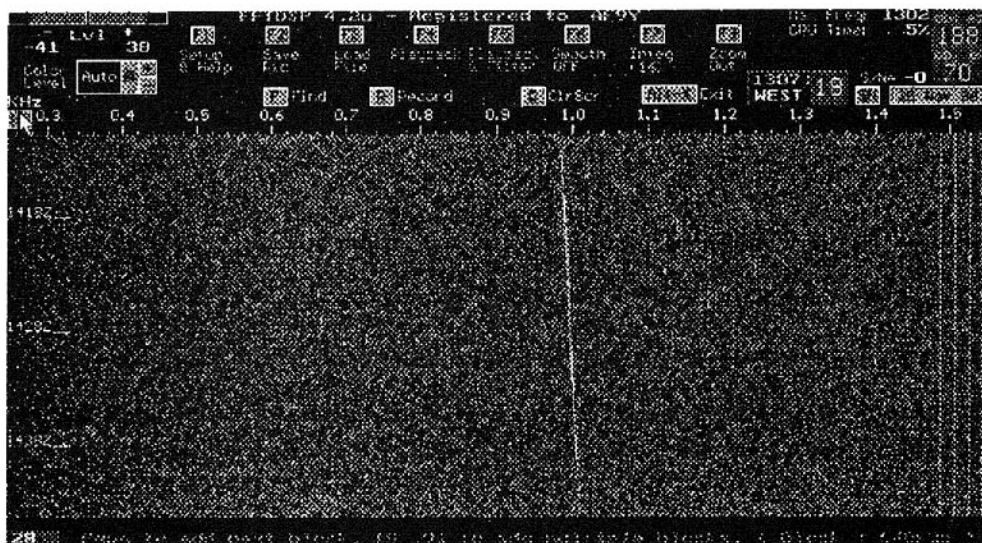
How can you join the Project Argus team? You might start by checking out The SETI League's extensive documentation on the World Wide Web, nearly 1,000 documents exceeding 26 MBytes! Point your browser to <http://www.setileague.org/>. If you lack Web access, you can email your postal

address to [join@setileague.org](mailto:join@setileague.org), or phone it in to the SETI League Membership Hotline, 1 (800) TAU-SETI, and introductory material will be sent to you through the mail. *The SETI League's Technical Manual* (ISBN 0-9650707-2-7) and other books will show you how to build your own amateur SETI station, for between a few hundred and a few thousand US Dollars.

Full sky coverage is not likely to occur overnight, but with a clear goal now articulated, it does stand a reasonable chance of becoming a reality. If signals are out there to be heard, I expect we will be able to detect and verify them, maybe even within my own lifetime. It takes only one verified signal to answer definitively a fundamental question which has haunted humankind since first we realized that the points of light in the night sky are other suns: Are We Alone?

If, on the other hand, after a generation or so of careful searching, we have still detected no evidence of other life, then we may be forced reluctantly to conclude that we are very much alone, the sole communicative species in our corner of the cosmos. Is not that discovery, too, worth the price of admission?

Either possibility, I am continually reminded, boggles the imagination. ■



**This CW signal from the Mars Global Surveyor was received by SETI League member Mike Cook on 25 November 1996, while the spacecraft was about 5 million km from Earth. The satellite's 1.3 Watt beacon transmitter, into an omnidirectional antenna, provided SETI enthusiasts with an excellent dry run to verify the operation of their receivers and digital signal processing software. Several other SETI League members were also able to recover the signal utilizing Mike's FFTDSP shareware program. (AF9Y image)**

# Results of the 1997 AMSAT Field Day Competition

Andy MacAllister, W5ACM

[w5acm@amsat.org](mailto:w5acm@amsat.org)

The 1997 AMSAT Field Day Competition was held in conjunction with the yearly American Radio Relay League Field Day in June. Rules for the AMSAT activity were similar to those posted by the ARRL, but with a few key exceptions. While the ARRL rules lump all satellite activity in one category, the AMSAT rules differentiate activity via different hamsats as separate bands. The AMSAT rules also provide bonus multipliers for digital satellite downloads and uploads of Field Day greeting messages.

The 1997 competition was very active. Every available amateur radio satellite had Field Day participants in pursuit of contacts. Several DX stations joined in the activity. Three sent in reports this year including ZS6BMN, OZ2SAT and HR2KOS. DX stations are encouraged to participate in the AMSAT Field Day activity.

Without AO-13 some problems were noted with loading on the low-orbit

satellites, but operation via AO-10 was excellent during close-approach periods.

The entry sheet was not modified this year and the rules were easily understood by most of the stations that submitted entries. There is still some confusion regarding digital-satellite messages. The only message downloads that count for Field Day are those that are addressed to **ALL** and were uplinked during Field Day as Field Day greeting messages.

Download listings and analog contact Dupe sheets were requested from some stations this year. A few serious inconsistencies were unfortunately noted causing at least one disqualification. If you have a high score next year, please keep good logs or dupe sheets. All top-scoring entries will be requested to provide at least dupe sheets and digital-satellite DIR listings. Some stations already send complete logs along with their entry sheet.

As a test, a few stations were encouraged to send their entries via the

Internet. A few rough edges were worked out and electronic submission of the Satellite Summary Sheet via the e-mail will be accommodated and encouraged next year.

Many thanks to all of you that operated in this year's event. It was a great opportunity to show other Field Day participants how easy and exciting satellites can be. It was also a chance for some competition on the birds and an occasion to test hamsat radio gear and antennas in emergency conditions.

No rule changes are expected for the 1998 AMSAT Field Day event at this time. There have been Field Day rule discussions via [amsat-bb](mailto:amsat-bb) on the Internet, and I have received some ideas for rule changes through the mail. What do you think? Please send any comments to Andy MacAllister W5ACM, AMSAT VP User Services, 14714 Knights Way Drive, Houston, TX 77083-5640. Now on to the members' Field Day comments:

## 1997 AMSAT Field Day Results

| Place | Call   | Points | Class | Group Name                                             |
|-------|--------|--------|-------|--------------------------------------------------------|
| 1     | KD6OZH | 275    | 1E    | John Stephensen                                        |
| 2     | N2WM   | 256    | 3A    | Sussex County Amateur Radio Club, New Jersey           |
| 3     | K4BFT  | 216    | 5A    | Huntsville Amateur Radio Club, Alabama                 |
| 4     | W5IU   | 208    | 3A    | Lockheed Martin / Kilocycle Clubs, Fort Worth, Texas   |
| 5     | K2LF   | 198    | 2A    | Overlook Mountain Amateur Radio Club, New York         |
| 6     | N8AM   | 197    | 1D    | Tom Flowers                                            |
| 7     | ZS6BMN | 189    | 1D    | Jan Hattingh                                           |
| 8     | WA0VTU | 162    | 2A    | Pike's Peak & Mountain ARC's, Colorado                 |
| 9     | K5DX   | 143    | 2A    | AMSAT-Houston & Texas DX Society                       |
| 10    | W4AKH  | 141    | 2A    | Fort Pierce Amateur Radio Club, Florida                |
| 11    | N7SFI  | 138    | 2A    | Utah AO-27 Group                                       |
| 12    | WN6NWG | 112    | 5A    | Palomar Amateur Radio Club, California                 |
| 13    | N1JEZ  | 106    | 1E    | Michael Seguin, Vermont                                |
| 14    | W8MRM  | 94     | 2A    | Motor City Radio Club, Detroit, Michigan               |
| 15    | OZ2SAT | 65     | 1D    | AMSAT-OZ, Denmark                                      |
| 16    | K4TN   | 61     | 2A    | Brandon Amateur Radio Society, Florida                 |
| 17    | VE3WCC | 55     | 2A    | West Carleton Amateur Radio Club, Ontario, Canada      |
| 18    | N4DAZ  | 48     | 1A    | Central North Carolina DX Chasers                      |
| 19    | VE3RAM | 43     | 3A    | Ottawa Valley Mobile Radio Club, Canada                |
| 20    | KA1MM  | 39     | 1A    | Hebron Allstar Wireless Gang                           |
| 21    | K6HAI  | 20     | 4A    | North Shores Amateur Radio Club, San Diego, California |
| 22    | W5VAD  | 19     | 2A    | Benton Amateur Radio Society, Arkansas                 |
| 23    | HR2KOS | 14     | 1D    | Lone Ricker                                            |
| 24    | AA8V   | 3      | 2A    | Appalachian Amateur Radio Association                  |



**John Stephensen at KD6OZH:** John operated at home with emergency power in the LAX section. For 1997 this was the highest verified score in the AMSAT Field Day competition.

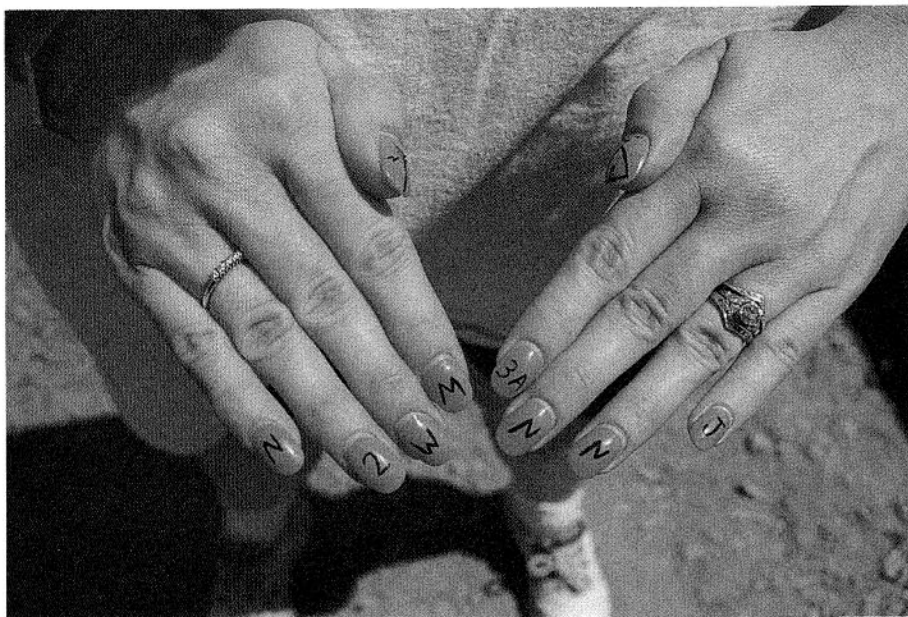
**John Santillo, N2HMM for N2WM:** John and his group, the Sussex County Amateur Radio Club, had the highest verified score for emergency/portable operation. The Fuji satellites provided the most analog contacts while the 9600-baud digisats provided 189 points in the upload/download count.

**Tim Cunningham, N8DEU for K4BFT:** The Big Fat Turkey (K4BFT) has operated several AMSAT Field Day competitions. This year the group at the Huntsville Amateur Radio Club focused on all the digisats, both 1200 and 9600 baud, for the majority of their points.

**Doug Howard KG5OA for W5IU:** The weather was hot as usual. Randy McKinney, N5SVW put up a thermometer at the beginning of the contest period. Reading 97°F it was promptly taken down. We got a mid-afternoon rain shower, but it was a light one and a tarp provided protection for the gear. Otherwise, it was generally hot and humid. We sure did miss AO-13, but the Fuji satellites provided some good QSO's. We never heard anything from AO-27, should have made more of an effort on RS-12, but RS-15 served pretty well. It is interesting to consider what Field Day will be like with Phase 3D in orbit! We used WiSP (32-bit version) this year under Windows 95. Roy Welch, W0SL provided help with the software during the week before Field Day. It worked out well. Chris Jackson did a great job on this fine piece of software. Operators included Keith Pugh, W5IU; Randy McKinney, N5SVW; Donna McKinney, N5WOE; Steve Yates, AA5TB; and KM5JF.

**Ronald Osborne, N2OGB for K2LF:** Digital contacts dominated the activity for the Overlook Mountain Radio Club. Equipment included Cushcraft antennas on a tripod, a Yaesu FT736R, AEA DSP2232, RF Concepts amplifier/preamplifier, Compaq notebook running WiSP and a Kodak DC-20 for photographs.

**Tom Flowers for N8AM:** Having been completely off the sats for over three years due to a school SAREX contact in 1993, I



**N2WM - 3A in Northern New Jersey is proudly displayed by Dawn Payne, N2NKF.**

finally found time to put the station back together just in time for this year's Field Day. I enjoyed AMSAT's version of FD immensely. The constant procession of the numerous satellites in the various modes provided a variety of operational challenges. It was particularly nice of those in charge of the orbital elements to slow down this hamsat parade in the wee hours of the morning so that one could get some sleep before the pace picked up later on. All available satellites were worked with the exception of AO-27. Next year I hope to remember to set my buffers and files to something far larger than 10 on the computer that runs my PB microsat

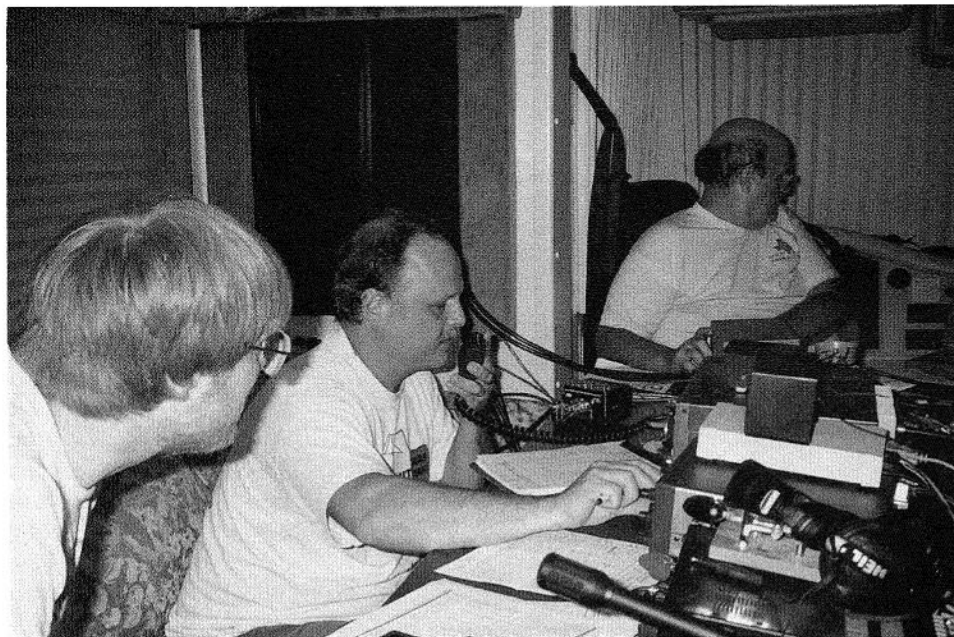
software *before* the contest. Since Field Day I have become fond of RS-15's weak-signal challenge. The situation spurred me to throw together the 28 MHz dual-gate MOSFET preamplifier circuit shown in the Satellite Experimenters Handbook. This has made RS-15 CW QSOs a whole lot more enjoyable.

**Jan Hattingh for ZS6BMN:** The main purpose of my participation in the 1997 AMSAT Field Day was to provide a DX Field Day message on the digital satellites. On those hamsats a ZS call can almost be classified as rare DX.



**Working AO-27 maritime mobile on Bear Lake, Utah at N7SFI.**





**AMSAT Awards Manager Mike Scarcella, WA5TWT (c) logs another FO-20 QSO while Marty Smith, WD5DZC (l) and Charlie Keng, N5XGW (r) observe at K5DX.**

**Tom McDaniel, N0NTX for WA0VTU:** The participants at the Pikes Peak Radio Amateur Association and Mountain Amateur Radio Club had great fun this year. It sure was nice to see the DX stations on line for this. My only complaint is that I would have liked to have seen more digital stations play!

**Andy MacAllister W5ACM for K5DX:** Once again the Houston AMSAT group teamed up with the Texas DX Society for Field Day. Excellent generators, motor homes, Texas BBQ and air conditioning made it a great outing. This year's focus was on analog operation. The only digital

gear at the hamsat station was for terrestrial packet. We managed to make 26 CW contacts and 65 voice QSOs during the event on every analog hamsat in the sky. The Fuji satellites took first place for ease of operation and QSO count, while RS-15 and AO-10 came in second. We even made four contacts through the incredible pileup on AO-27. Operators and visitors were numerous, and all had a good time. A dedicated 15-meter dipole for RS-12 uplinks and a four-element Yagi on 10 meters for RS-15 downlinks really made a difference. We'll put the digital stuff back online next year with a separate station.



**Brandon Amateur Radio Society, K4TN Field Day station in South Florida.**

#### **Roger Snyder, K4RS for W4AKH:**

The 1997 Field Day was quite a success for the Fort Pierce, Florida ARC. Even though my usual partner in the event N4XEO was unable to attend, we managed to score more points than my previous year. Problems this year included rotator problems, a bad coax connector, RF interference and some power concerns. With RS-10 and AO-13 out of the picture, the Fuji birds became the workhorses for the analog mode. Congestion on AO-27 was much worse this year. With so many people calling at once, few were getting through. On the other hand, the digital birds were excellent. KO-23 and KO-25 worked flawlessly. I had some problems receiving UO-22, but I attribute that to my small antennas. Participation by DX stations really helped and is greatly appreciated. The weather was wonderful for a change. Our Field Day site was located in a park on an island off the east coast of Florida. There is something special about watching sunrise while standing on the beach. The food was great and everybody had a good time. I am looking forward to using Phase 3D.

#### **Randolph (Randy) Kohlwey for N7SFI:**

We were on the shore of Bear Lake, Utah. The operators of the Utah AO-27 Group were Eldon Kearn, KB7OGM; Lyle Nelson, KC7KSA; W. G. Phillips, KC7LNT; KC7QFS; and Randy Kohlwey, N7SFI. Digital points dominated our total, but we still made 24 voice contacts, nine through AO-27.

#### **Paul Williamson, KB5MU for W6NWG:**

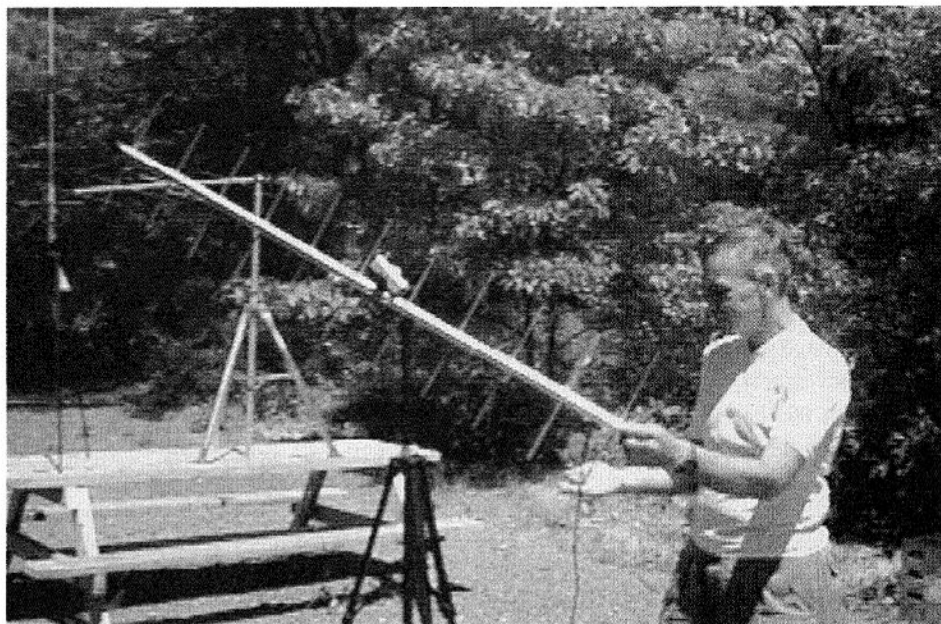
Operators of the Palomar Amateur Radio Club included Duane Naugle, KO6BT; Paul Williamson, KB5MU; and David Daun, KC6YSO. We listened to the RS birds, but the HF antennas were inadequate. The AO-10 transponder was drift, but working. I downloaded one greeting file from KO-25 (from WU8C) but it was uploaded before the Field Day period, so I assume it doesn't count. Later in Field Day we were unable to get KO-25. A couple of stations uploaded several greetings diverted to specific Field Day stations. Those as well don't count. As usual it was fun, but a lot of work. Now to put my station back together!

**Mike Seguin for N1JEZ:** I decided to enter as 1E (emergency power at home) this year primarily to test the battery power systems for the VHF rover system I use in the ARRL VHF contests. It worked really

well. However, shortly before the contest I accidentally powered my two-meter amplifier backwards and blew the internal fusing. Fortunately I was able to borrow another amplifier from my roving partner Beau Bushor, N1MJD. Thanks Beau! Activity on the satellites seemed average with the usual myriad of stations madly searching for their downlinks amid stations calling CQ. I found that search and pounce seemed to work well, with the occasional run on a fixed frequency. The Yaesu FT736R, with locking VFOs did exceptionally well with the muTek mods. I could easily distinguish weak signals near the loud ones. Unfortunately the weaker guys didn't always hear me calling them. I had loaned my Arrow antenna and ARR 70-cm preamp to another Field Day group. They made two AO-27 contacts, one with a five-Watt HT! Considering the mess on AO-27, I consider this a miracle.

**Michael Rudzki, N8MR for W8MRM:** Every Field Day I try a new experiment. Apart from the single RS-12 contact, all my digital contacts were made through an Arrow II satellite antenna. AO-10 was unusable for me and Phase 3D is still only a dream, so we went with a simple system. We didn't set any new scoring records, but we had plenty of fun and learned a few more things.

**Ib Christoffersen, OZ1MY for OZ2SAT:** During the winter we decided to participate from the club station at the Engineering College of Copenhagen where I work. We used the AMSAT-OZ call OZ2SAT. It was our intention to use both the digital and analog satellites, but unfortunately the digital part didn't work out. On the analog side we had three very experienced CW operators. We thought this would be a good move since CW gives three points per contact. RS-12 proved to be the best satellite for CW which was no surprise to us. On RS-15 we heard a few stations from North America (N8AM, N2WM & W1TQ), but for one reason or another they did not hear us. In fact we only worked one station in North America, and that was on AO-10. Sometime in the afternoon on Sunday we stopped since the average age in our group was above 50 years and there was a long period without any useful satellites. We had great fun during the event and will surely participate again next year, this time with a functioning digital station. Participants included OZ5ABD, OZ5LH, OZ6BL, OZ2ABA, OZ1LLR, OZ7JWP,



Overlook Mountain Amateur Radio Club K2LF Field Day station in New York.

OZ9VQ, OZ1EH, OZ8NJ and OZ1MY. See you in Toronto!

**Jim Huhta, AA4MD for K4TN:** This year the Brandon Amateur Radio Society operated from a public park near Brandon, Florida. There were 33 hams and 57 others in attendance. My first KO-23 QSOs were made at Field Day. Thanks to Barry Baines, WD4ASW for his patient answers to my many questions. We lost eight hours due to a bad coax connector. Next year!

**Gene Schmig, KQ4AV for N4DAZ:** The Central North Carolina DX Chasers were back again this year operating class 1A on the analog hamsats. We had 39 voice contacts and nine CW QSOs.

**L. Claire Fowler, VE3NPC for VE3RAM:** The Ottawa Valley Mobile Radio Club operated class 3A using emergency power. All contacts were via the analog satellites with 40 phone contacts and three on CW.

**Walter S. Midura, Jr. for KA1MM:** Competition was hot and heavy on RS-12 this year. The downlink signals were excellent.

**Dave Guimont, WB6LLO for K6HAI:** This year we concentrated on public relations. The event was held in a recreation area and we had about 40 visitors. A nice article appeared in the June 29th issue of *The San Diego Union-Tribune* about our activities. The title? Ham Radio Operators Are Having a Field Day... what else?

**Bill White, N5XYN for W5VAD:** The Benton Amateur Radio Society of Arkansas pursued the analog satellites this year. Thunder showers and rotator problems lowered our score. Operators were Bill N5XYN and Arlie WB5IFH. Antennas were all homebrew with nine elements on two meters, 11 on 70 cm and a 15-meter ground plane. RS-10 was sorely missed.

**Ricardo Denis for HR2KOS:** This year in Honduras was better than the last. Too bad AO-10 wasn't running well, as it would have been my first year on it for Field Day. I made almost as many contacts this year as I made the previous two years together. See you next time!

**Pat Woods, N3AAS for AA8V:** The Appalachian Amateur Radio Association only got three contacts this year, all through FO-20. It was a lot of work for so few contacts, thanks to Murphy, but we're looking forward to Field Day 1998 and Phase 3D.

All the best! Andy ■



# Observations From Norway

John A. Hackett, LA2QAA

Packet: *la2qaa@la6k.ksu.t.nor.eu*

The following is the gist of a message I threw to the wolves recently. (He means he put it on the packet network folks....LA2QAA.) in the hope that the potential newcomer might understand why some of the *experts* do and some don't! Or, why some go up and some go down all proclaiming the *other chap* is wrong.

Gentlemen,

Regular users of the Fuji series satellites are no doubt aware of the Weekly Satellite Report distributed by the AMSAT News Service on the packet network stating I quote:

*"Please remember to adjust the higher frequency for Doppler when the bird is in the analogue (JA) mode. This means adjust the 70 cm frequency, the uplink, for Doppler".....(end of quote)".*

I now quote from the *Space Radio Handbook* by John Branegan, GM4IHJ.

*"The golden rule of FO-20 mode JA operating is to keep moving your transmitter uplink frequency so that your downlink signal stays in the same place on your receiver. This allows both you and the station you are communicating with to use your respective receivers as a firm reference for where you are. If you do not do this you will find that after you have been*

*talking for a minute or so, the other station will appear to reply on a quite different frequency, noting that with 11 kHz of Doppler shift you move through the 2.5 kHz bandwidth of a SSB receiver more than 4 times in an FO-20 orbit passing near your station".....(end of quote).*

Two completely different conventions....one *American* and one *European*...or, one could say, one *technically* correct and one *logical*. So what do we do? I have written to the editors of both AMSAT-UK and AMSAT-NA requesting that we *get our act together* before Phase 3D takes to the sky. For some it will be difficult to change a habit of perhaps several years but for the benefit of all we should *all* use the same convention when adjusting for Doppler otherwise we will continue with the chaos sometimes found on FO-20 and FO-29.

My own personal suggestion is that the designers of the spacecraft together with the control stations should decide on an *International* convention and we the users *all* follow it.....(The blind leading the blind, said he....LA2QAA).

It's Saturday AM, the 28th June...just 48 hours prior to the R. Tillman Esquire inspection of the QAA shack...(just operated FO-29 and was *drowned* with questions like "izzy thereyetorwot?") quite naturally I'm running round like a headless

chicken making sure the Bentley (read: Wartburg Knight) is polished properly, the Larsen Black label is suitably chilled etc....of course I am! joking, mind, I think we can run to a Tetley's teabag!....(if we share it).

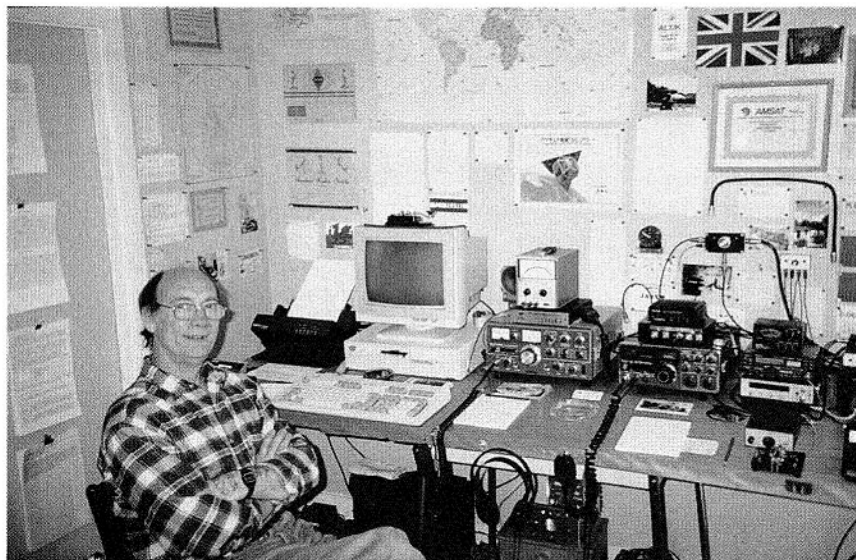
Actually, I'm quite proud of myself, being blessed with a bone idle nature it was no mean feat wrestling with the lawn mower over an area that looks like a Central American jungle in full bloom (*Herself* calls it *the garden*). The grass is now the regulatory length of 3.2mm pr: blade.

That rather reminds me of a jaunt to one of the aforementioned Central American Republics...HRH...(Phil)...was destined to overfly the jungle in a helicopter. The warlords decided the occasion should be suitably *marked*. Therefore, I and the rest of "A" company spent three fine days swinging machetes clearing jungle that had until that day rested in peace for no doubt the last thousand years! Not content with that the warlords had us write *WELCOME HRH* with musty old coconut husks in the now pristine clearing. [Nobody bothered to tell the warlords that from 3000 ft one wouldn't even see the clearing (!) let alone the inscription] How about that for taxpayers money put to good use?

Particularly nice to work John G7HIA on the aforementioned FO-29 pass....(and Lothar DL6YBD *lurking* in the background). The last time I worked Lothar he was *stuck* on his roof! Little wonder the non-satellite public think we're a somewhat *strange* species.

As can be imagined, the Tillman visit is quite an event and for me personally, an honor.

While coordinating the *shacktime* with Russ's relatives I was told that he had been given strict orders from *The Boss* that she didn't want to hear the word AMSAT for the duration of the holiday/vacation. Therefore *bribes were proffered*. LA2QAA suggested that perhaps *The Boss* would like to go *shopping* while I *borrowed* Russ for a while...promising to return him unscathed after several passes of FO-20/FO-29. This suggestion was of course met with



LA2QAA at his QTH, Frei Island, Norway. (KC5JVB photo)



approval. On telephoning the lady relative to final confirmation of the *pick-up* and *delivery* time of Russ I was informed that the suggestion was perfectly (!) suitable because the ladies had planned to set a world record (!) in *shopping* while Russ and myself spent the time *Fuji-hopping*. I hate to think what these couple of passes will cost Russ. The things some people do to operate satellites! He'll probably never speak to me again when he gets the bill!

There seems to be a rumor circulating that LA2QAA is quite a nice chap really and reasonably intelligent to boot. I can assure (or rather *reassure*) the regular readers that this rumor is completely unfounded.

By the time you're reading this, the *Tillman Inspection* is history. I must say, it's been *many* a long year since I've met such a nice *gentleman*. I also had the opportunity to meet Russ's charming wife Dottie and daughter Blair. My XYL was charmed *speechless*. (I'm gonna have to watch this guy!) The prearranged skeds with Malc Hall, G7NFO and Lothar, DL6YBD went like clockwork despite a sticking rotator and an immovable mountain. My only regret was that the visit was so short due to such a tight schedule but we have agreed on regular skeds when Phase 3D is operational. One of the things we briefly talked about between passes was the continuity of the officers of AMSAT and the designers of the spacecraft. Sooner or later, someone has to *take over the helm* to ensure continuity. I recall James Miller, G3RUH stating that nobody seemed to be teaching themselves the technique of ground station control. In the April 1997 issue of *OSCAR News* AMSAT-UK chairman Professor Martin Sweeting, G3YJO reminds us that posts need to be filled on the administration side. All of which require *dedication* over a period of perhaps five years or more. There are undoubtedly a few people out there who are capable of such a commitment. I hope they come forward. While on the soapbox. One doesn't necessarily have to hold a degree in either this, that or the other to support the organization. Even a reader's letter is a *contribution* (*constructive* criticism is always welcome.....*bitching* we can live without).

You can all stop sending me your used 10 pound notes now (100 dollar bills if you're American) because *once more into the breach*, etc having now rejoined the

ranks of the (un)gainfully employed the bread and water *diet* will no doubt be replaced by a jam butty (!) for Sunday lunch. I even got an office thrown in this time! (I'm pretty sure the Kultural Department here found it wiser to have me where they could *see* me rather than letting me run round loose.) In either case it means the coffers can be replenished.

More on Elmer-ing. I had a lengthy chat with Martyn Snow, G0CZD yesterday via the *dog n' bone*. (I'll probably have to sell the car to pay the bill but this was *microwaves via satellite* so who needeth a car anyway.) Being from Crewe myself, but not having been in the UK for the last 17 years!...(you really don't want to know why).....I couldn't resist the opportunity of yattering away for almost an hour! Which brings me to the point (it has been mentioned before) *please* do not call the Elmers at 3 AM in the morning and ask why this or that oscillator is unstable, etc Remember Elmers have wives and families as well as work commitments, etc. So try to be as brief as possible, write down your questions beforehand and be ready to anticipate the reply so you won't need to *waffle* and waste time. The time is freely given and the Elmers are a great source of information but do please use a bit of *common*.

Conditions have been rather unstable on the 70cm downlink of FO-20 this last week or so (mid July) while the European stations have been weaker than usual the stateside stations have been booming in. I worked B. J. Arts, WT0N a few minutes ago (25JUL97@1525Z) with (genuine) 59 reports both ways. I was using my usual 5 watts to a single 6 element vertically polarized Yagi. The downlink was via a 6 element horizontally polarized Yagi. Proof that circular polarization is not a *necessity*. As mentioned in a previous *Observations*, a circularly polarized wave is only *circular* in the direction of the main lobe anyway. Therefore, having linear polarized antennas, one vertical and one horizontal, is a fair compromise. For the newcomer, it all depends on where you (!) are situated, which satellite you're working, where your QSO partner is situated, Faraday rotation, spin modulation and what color your socks are! Use circular polarization if that is your want but do make sure the satellite antenna and yours are not cross polarized. Otherwise you'll be wondering why the

signal has QRP'd. Remember the basic rule...all antennas on the same plane.

Again for the newcomer....(also "sed" before)....I mentioned WT0N...he distributes the AMSAT News Service (ANS) bulletins via e-mail, WWW, and packet. He has noticed several stations just lately, particularly on FO-20 (newcomers?) using far too much power on the uplink...thereby *stealing* power from the other users.....try to remember.....upping the TX power until you can hear yourself is definitely *not* the way to go...it is in fact downright bad manners!....the *correct* way to go is improving your receive capability....that means...either an antenna with more gain or for those that can't manage that, a decent preamp. The point being....you should *never* have a signal stronger than the beacon...try to get into the habit of *always* tuning in to the beacon before *roaring* into the microphone....the beacon is the reference. I find 5 watts to 6 elements quite adequate on FO-20. Of course one won't get far with a system like that on AO-10....(I needed a circularly polarized 16 element Yagi on the uplink with 5 watts...and a 13 element horizontally polarized Yagi for the downlink...even then I was *weak but workable*.) If Phase 3D all goes well will be a different matter altogether....5 watts to a damp shoelace should be sufficient for mode-B operating....assuming one remembers to remove the bananas from ones ears first.

I'm not getting much joy out of AO-10 these days mainly due to said bird refusing to rise above 5 degrees over the horizon of late...which doesn't help when you have a rather *obese* hill (actually, it's a range of mountains on the mainland) blocking the view. On the other hand FO-20 is still *getting it on* as soon as the central European stations drop out of the passband....at this stage of the cycle at least....I have a nice quiet window into North America....even managed a mini ragchew with Ron Seiler, VE7VWV this afternoon (26JUL97) as well as a quickie with Dan James, KE0DH.....seven countries in two passes.....not bad for a LEO like FO-20.

Today is the 27JUL97 and it's absolutely *hissing* down...(with a capital P)... still....the conditions seem to improve with the rising moisture content in the air so I shouldn't complain really...over the period of the last several weeks I've made friends with Vladimir Timokhov,

RA3DQT who has become quite a regular on FO-20. This morning Vlad told me about a contact with BY4XJ....makes you want to up-sticks and move to sunny Siberia. From his European location of KO95HI Vlad pulls in stations *the rest of us* can only dream about.

As of this date FO-29 is in analogue again but is always behind *my favorite hill* so probably will only catch it with knife edge propagation this period. Here is the current schedule for FO-29:

Sept 26(Fri) 08:09z JA  
 Oct 3(Fri) 08:46z Digi-talker  
 Oct 13(Mon) 08:26z JD1200  
 Oct 17(Fri) 08:18z Digi-talker  
 Oct 20(Mon) 07:21z JD9600  
 Oct 24(Fri) 07:13z Digi-talker  
 Oct 27(Mon) 07:59z JA  
 Oct 31(Fri) 07:51z Digi-talker  
 Nov 4(Tue) 07:43z JD1200  
 Nov 7(Fri) 08:29z Digi-talker  
 Nov 10(Mon) 07:31z JD9600  
 Nov 14(Fri) 07:23z JA  
 Nov 21(Fri) 08:01z Digi-talker  
 Nov 25(Tue) 07:53z JD1200  
 Nov 28(Fri) 08:39z JD9600  
 Dec 5(Fri) 07:33z JA

## Mode-S

I'm still receiving DOVE with reasonable signals on 2401.220 MHz. Today I also listened to UO-11 on 2401.500 MHz. The orbit nr: was 71718 and best reception was at 15:04Z on the 27JUL97. Azimuth 329 degrees and elevation 14 degrees. I was using a home brew 50cm diameter parabola to the GOMRF converter and Microwave Modules 70cm/10m converter to an old TS-520S. I have a home made step attenuator in the system with 3, 6, 10 and 20dB steps. Using 10dB of attenuation between the 2.4GHz converter and the 70cm converter helps to get rid of the excessive receiver noise caused by two converters in series. The 50cm parabola is made *stressed dish* style with aluminum spokes and covered with aluminum wire mesh. This is fine as long as the *holes* are less than about a tenth of a wavelength. The feed is exactly as described by James Miller G3RUH. James stated a 60cm dish would be adequate for Phase 3D then later said it would be *"more than enough"*. I can confirm that. It will most probably be overkill judging by the signal strength I get from DOVE with 0.8W. Of course Phase 3D will be a couple of stone's throw further

out in space but then it will be transmitting a little more than a puny 0.8W. Karl Meinzer says that a 60cm dish will be just fine for all the microwave bands from 2.4GHz and above. A fair guess for 1268 MHz would be a 10 turn helix with about 8 watts...(don't forget to take into account the losses in the transmission line)...I'll describe my home brew 50cm dish...(cost me 300 pence!)....and the 10 turn helix (presently *"under construction"*)....as soon as I get a *"round tail"*. For those that have trouble with Doppler on FO-20....just you wait until you come *"up here"*....you'll love! it. I'm currently trying out a novel home brew idea for tracking these LEO's on 2.4 GHz....my TR-851E has all mode squelch and that gave me the idea for the following.....an old fashioned VOX circuit (LM3900 quad comparator) and pulse generator (Ua555) to the mic up/down buttons with an inverter between the VOX and pulse generator. Audio from the satellite beacon...(with the squelch just above the threshold point) keeps the output of the comparator high...that is to say...nothing happens!....as soon as the signal drops down the comparator goes low and pulses the generator which clicks the mic button down a step....the antivoice ensure the system doesn't *throw a wobbly*....(for



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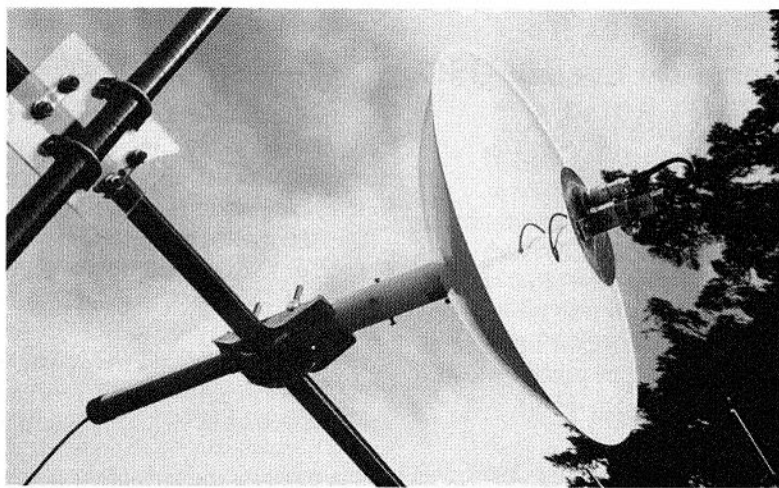
our American cousins, it means: *go mad*).....I even have a center meter built in for *visual* control.....makes things easier when chasing DOVE with it's 100 kHz of Doppler....not really a *practical* project but a *fun* experiment. Perhaps some wise young American will turn it into a multi-billion dollar commercial thing for NASA's continuing space program.....just remember though, it was *born* on Frei Island...hi....

Just worked VE7VWV again...getting to be a regular habit...however, I got my Y-fronts in a bit of a twist this time because Ron said I didn't know I'd been talking to a *celebrity*.....quite naturally I assumed him to be referring to the *higher echelons* in London....I think he was a bit disappointed when he realized the only letters I have after my name are OBS.....our illustrious *OSCAR News* editor Fred Southwell, G6ZRU assumes that to be an abbreviation for *Observations* but actually it's an abbreviation for *Old, bald and senile*!.....which describes "I" to a "T"

The holiday season abounds.....Alex Gordon, G4TTB *popped* in yesterday....(how do they find! this place)....I was convinced it was *remote*. Alex needed photo's for a Radcom article so those wondering what *secret* antennas LA2QAA uses will soon be able to see....providing they receive Radcom.

Received a couple of welcome letters from John G7HIA, AMSAT-UK 2-meter net controller and Clive Wallis, G3CWV the author of the regular *Haven't Got a Callsign* column in *OSCAR News*. John also makes it clear that one doesn't necessarily have to be a relative of the Getty family to afford to operate via satellite. Recent readers of this column will undoubtedly realize my average income has been less than a well heeled church mouse....never-the-less...I've always managed to have a lot of fun with the means at my disposal...the secret?...a bit of *common*, the ability to improvise and of late...a good Elmer....I'm in the process of *messing about* with microwaves. Hopefully I will soon be able to present a workable system for the 1.3GHz uplink on Phase 3D which will cost less than a fortnight in Bermuda.

A question often asked by the newcomer....why the perpetual drive to higher frequencies...what's wrong with mode A?.....Nothing! I will attempt to



LA2QAA's Mode-S antenna. (KC5JVB photo)

explain in a way understood by the complete novice to satellite operations. As will be realized, the power available on a satellite is not infinite. Batteries need a charge to operate efficiently. Constant use by many stations drain said batteries. More users = less power to be divided between each user. Logical? So far so good. Incidentally, you'll now appreciate the term *alligator* and why your receive system should be optimum. Turning up your power to balance out an inadequate RX system is both silly and unnecessary. Now...imagine this....an 80 meter dipole on a satellite. Ridiculous isn't it! Follow that thought, it doesn't take too much *gumption* to realize that at the higher frequencies (read: smaller physical size/more gain etc) a lot more equipment can be accommodated in a limited space (pun intentional). Also, commercial interests are demanding their share of the cake....(read: radio spectrum)....remember the adage...*use it or lose it*. All in all, the microwave frequencies are going to be *where it's at* in the next century. Think about it....so next time you want to *whinge* about "no 73 Hz on Phase 3D"...brains in gear before engaging gob!...please.

Surprise! After 6 months, the QRT packet link between western Norway and civilization has been restored. (3AUG97). I thought the sun only shined on the righteous?

Just completed another QSO with 'me mate G7NFO.....(so what?) Well, a good example of how to work through the bedlam! Just prior to our QSO I was monitoring the FO-20 passband. Now, I've been operating this satellite *daily* for the last 12 months...(keeping tabs as a monitor station). The QRM, some of it quite

deliberate, was appalling! There is perhaps some excuse for this kind of operating on 20m but certainly not via satellite where everyone *theoretically* can hear everyone else. Again, some of the stations boasting about their high powered amps and large arrays....These are not necessary under normal propagation conditions on FO-20. If you have a 10Db gain antenna please do *not* feed it with 50 watts of RF power. You overload the transponder, the signal is distorted and you undoubtedly spoil other people's QSO's. I am happy to say not one single station was among the offenders. As Malc, G7NFO agreed, it's a real pain in that part of the anatomy one sits on. In these *extreme* cases perhaps the only way to make the offenders see the errors of their ways is by *launching* the said amplifiers up the aforementioned anatomical orifice.

When Phase 3D eventually lifts off it will be equipped with an effective LEILA system.....either that or the offenders return to 20m. A couple of those I logged today were so called *experienced* operators. They should know better! Obviously in some cases due to the idiosyncrasies of the propagation...particularly on the 2-meter uplink....one can experience dead spots/blackouts...different angles of take-off through varying propagational conditions...so called FAI's etc but that doesn't mean you have to run the linear on a permanent basis "just in case"....the experienced operator first *listens to the beacon* before transmitting....and....knows what's going on in the rest of the passband....as opposed to blindly (!) drifting across other QSO's with the...*my amp is larger than yours*...attitude. Poor operating procedure to say the very least.....(Feel a lot better now I've got that off my chest). 73 de John. ■



## Observations from Vicksburg: An Eyeball QSO with LA2QAA Russ Tillman, KC5JVB

Last July, I had the opportunity to briefly visit John Hackett, LA2QAA at his country home located on Frei Island, Norway. While our visit was short, it was one that continues to support my opinion that AMSAT members are good folks, who are having fun doing good things.

I first ran into John a few years ago when I came across one of his *Observations* articles in the *OSCAR News*. That article included an impressive photograph showing his Mode B antennas covered in snow during a typical long and dark Norwegian winter blizzard. While I didn't know at the time that John is British, I was glad to see his article as it verified that Norwegians were active on satellites. Shortly after reading that article, Bill Hook, W3QBC forwarded one of John's articles for the *The AMSAT Journal*. Since then, John and I have developed a friendship through the exchange of many letters.

Years ago, my Mother's family left Bergen, Norway and settled in Waco, Texas. Despite the distance, we have always kept close relations with our Norwegian side of the family which these days outnumbers the American side. While e-mail and fax machines have been a recent improvement from the monthly exchange of postal letters with our Norwegian relatives, I have always been interested in working the *home country* on satellites. I think my Grandfather would be fascinated to know that these days you can point a

piece of metal towards the sky and with a little finesse, talk to the folks back home.

Last summer two of my Norwegian cousins visited us in Vicksburg. While explaining what these strange antennas were doing in our back yard, we discovered that John lives less than ten miles from their home in Kristiansund. It was during their stay that my wife, daughter, and I were talked into returning to Norway for a long overdue visit. Since we were going to spend a few days in Kristiansund, I was not about to let a chance to visit John pass me by.

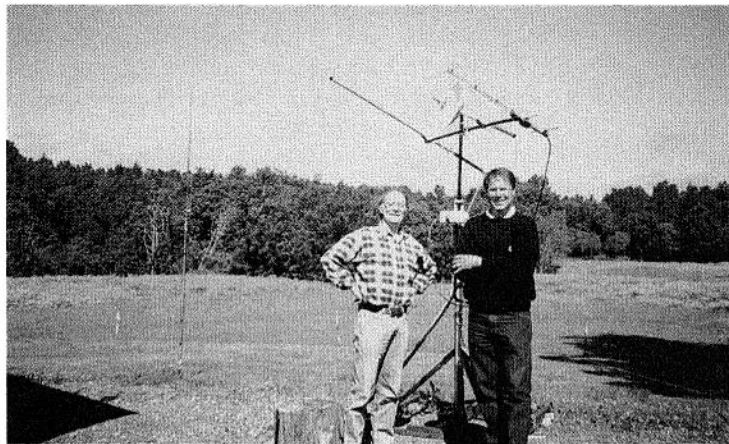
John lives on Frei Island with his wife Wynche, and their six-year old daughter Elizabeth. Frei Island, is one of thousands of islands that are spread along on the western coast of Norway. John is a former NATO employee, who like others fought and won the Cold War, only to find themselves without a job; a *peace-time dividend*. While his NATO position has taken him to places all over the world, until just recently, he was unemployed. Certainly, financial demands of raising a daughter along with other family commitments would put a serious crimp into anyone's satellite budget. To coin a politically correct term from John, he was *financially embarrassed*. However, John is a self-taught satellite operator who practices amateur satellite radio as an art. His financial situation left him the only option of experimenting and homebrewing to learn about and to work satellites. As a result, John has taught himself (and others) innovative ways to work satellites. I was also amazed to learn during our visit that I was the first AMSAT member that he has met face-to-face.

John reminds me of the late Tristian Jones, the British sailor who wrote numerous best sellers on his solo sailing adventures throughout the world. Like Tristian, years of British military experience has given John a very disciplined approach to Amateur Radio. It has also developed his unique sense of humor and zest for life that is reflected

in *Observations*! His shack is impressive as it is immaculate with everything in its proper place. Watching John work the FO-20 and FO-29 from his shack was worth the price of admission. As a result, when a satellite pass is about to occur, John doesn't just sit down, switch on the equipment and start talking. Rather, he savors each pass in hopes of learning something new. When the beacon AOS occurs, he listens to see if anything different can be learned from the signal before moving up frequency for a voice QSO. Upon making a contact, John portrays the same warm and friendly humor that is displayed in *Observations* and during our short eyeball QSO. During our brief visit, I was able to meet some of John's friends via FO20 and FO-29: Lothar, DL6YBD; Malcolm, G7NFO; Jose, ON1DDR; and Benji, F1UIM.

Like most AMSAT members, John is very excited and supportive of Phase 3D and the future of AMSAT. He shared with me much concern about his inability to make significant financial donations to Phase 3D because of his unemployment. However while being *financially embarrassed* he has more than made up for lack of financial contributions by contributing numerous articles for the *OSCAR News* and *The AMSAT Journal*. He also expressed much concern about how he could help recruit and keep newcomers interested in our hobby. John is truly an AMSAT fellow.

Back home in hot and steamy Vicksburg, Mississippi, I have cleaned up my shack to meet John's standards in hope of capturing some of the magic that he displayed while working the sats. However, it seems to be useless. The hectic process of getting a journal out every other month doesn't lend itself to having a LA2QAA shack. So I display a 500 MHz dummy load and tape measure antenna (circa AMSAT technology) in a prominent place in my shack; gifts from John that he acquired in his wheeling and dealing with the Norwegian oil industry. Meanwhile, FO-20 and FO-29 have become special to me since working them as LA/KC5JVB from Frei Island. From my QTH, John is *just out of reach* via FO-20 and FO-29 footprints. So we both wait for Phase 3D for QSOs. No doubt John will use Phase 3D to not only experiment but to make more new friends from remote Frei Island. As they say; *if you don't like satellite radio.....move to Norway!* ■



John Hackett, LA2QAA (l) and Russ Tillman, KC5JVB (r) in front of LA2QAA's antennas, Frei Island, Norway. (KC5JVB photo)

# AMSAT Journal Telemetry

## AMSAT-NA Election Results

AMSAT-NA Corporate Secretary Martha Saragovitz has announced the results of the annual election for the AMSAT Board of Directors. A total of 1,386 members cast ballots in this year's election and the results are as follows:

Bill Tynan.....1,234\*  
Stan Woods.....1,161\*  
Dick Daniels.....1,114\*  
Joe Holman.....993\*  
Barry Baines.....842#

The four candidates receiving the highest number of votes (\*) were elected to serve on the Board for two years. The fifth highest vote getter (#) will serve as the alternate until the next election. The newly elected board will meet at the site of the AMSAT-NA annual meeting in October. At that time they will elect AMSAT Officers.

## Students Build Functional Sputnik 40th Anniversary Model

On February 20, 1997, an agreement was signed between Russia and France to commemorate the 40th anniversary of the launch of the first artificial satellite of the Earth: Sputnik-1. Two groups of high school students will cooperate to build a functional scale model (1:3) of the original Sputnik satellite. Students from Naltchik in Russia will build the body of the satellite, and students from Reydelle School in La Reunion will build the radio beacon that will be launched from the *Mir* on October 4, 1997.

Meanwhile, Gerard Auvray, F6FAO Vice President AMSAT-F provides the following additional information about this Sputnik replica:

- The transmitter will be activated in October during an EVA from *Mir*. The lifetime of the satellite will be between 1 and 2 months.
- Sputnik will be launched by hand so it will not be very far from *Mir*. How-

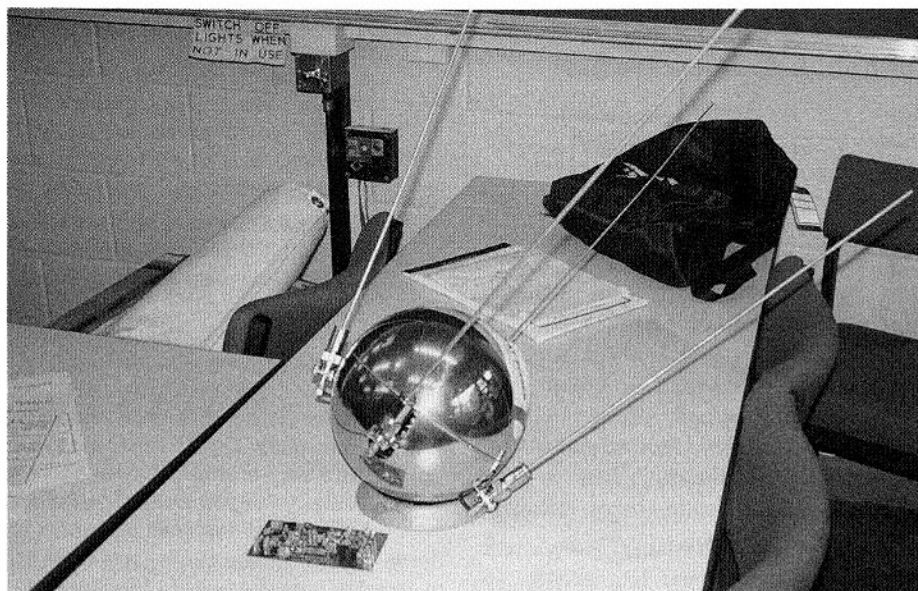
ever, *Mir* performs frequent orbit adjustments so it is uncertain how long Sputnik orbital elements will be the same that *Mir*. It is anticipated as for this will provide an exercise for students to try to compute the orbital elements by measuring Doppler shift.

- The transmit power is between 100 and 200 mW. The antenna polarization is circular, and will be right or lefthanded depending on how we will see the satellite. Sputnik has no attitude stabilization. The modulation is FM and the BF [audio] signal is around 1.3 kHz and it will vary with temperature. The RF signal sounds like a beep-beep as it is ON/OFF with a duty cycle of 5 percent. The full cycle is around 4 seconds.
- Beacon can be monitored in FM position or SSB position. If you want to measure the audio frequency you should be in FM. This will not be an easy exercise because it is a burst and the dynamic of frequency variation is low. In the best case you should be able to receive it on a handheld receiver with an antenna gain of 0dB, but, as we will not know the satellite's attitude in space it will be better to have a Yagi with 10 dB gain (around 9 elements).

## Satellite Orbital Elements

Ray Hoad, WA5QGD

| Satellite      | AO-10          | AO-27          | FO-20          | FO-29          | RS-10/11       | RS-12/13       | RS-15              |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------------|
| Catalog Number | 14129          | 22825          | 20480          | 24278          | 18129          | 21089          | 23439              |
| Epoch Time     | 97254.06336062 | 97254.19355447 | 97253.87280559 | 97254.16660162 | 97254.20162520 | 97253.99683474 | 97254.37223104     |
| Element Set    | 504            | 600            | 994            | 125            | 397            | 7              | 245                |
| Inclination    | 26.1933        | 98.5393        | 99.0536        | 98.5313        | 82.9266        | 82.9203        | 64.8171            |
| RA of Node     | 127.4733       | 326.478        | 199.3797       | 283.6305       | 175.1546       | 214.991        | 13.4743            |
| Eccentricity   | 0.6045096      | 0.00089        | 0.0541278      | 0.0351666      | 0.0012456      | 0.0031268      | 0.0147567          |
| Arg of Perigee | 150.525        | 359.844        | 183.2558       | 323.5727       | 350.9125       | 59.1304        | 115.8834           |
| Mean Anomaly   | 264.571        | 0.2747         | 176.4967       | 34.1942        | 9.1806         | 301.2906       | 245.7387           |
| Mean Motion    | 2.05881096     | 14.27735986    | 12.83238387    | 13.52632861    | 13.72381825    | 13.74085157    | 11.27528283        |
| Decay Rate     | -0.00000055    | 0.00000115     | 0.00000019     | -0.0000008     | 0.00000024     | 0.00000015     | -0.00000039        |
| Epoch Rev      | 10712          | 20634          | 35569          | 5274           | 51203          | 33094          | 11165              |
| Satellite      | RS-16          | UO-11          | UO-14          | AO-16          | DO-17          | WO-18          | EO-19              |
| Catalog Number | 24744          | 14781          | 20437          | 20439          | 20440          | 20441          | 20442              |
| Epoch Time     | 97253.74947330 | 97253.96091577 | 97254.23364375 | 97254.17553906 | 97254.15286780 | 97254.08274856 | 97254.18302701     |
| Element Set    | 104            | 29             | 296            | 107            | 92             | 113            | 116                |
| Inclination    | 97.2667        | 97.843         | 98.5151        | 98.5319        | 98.5359        | 98.5332        | 98.5391            |
| RA of Node     | 157.1835       | 231.8001       | 334.0245       | 337.0857       | 337.9869       | 337.802        | 338.6204           |
| Eccentricity   | 0.00082        | 0.001291       | 0.0011093      | 0.0011104      | 0.0010561      | 0.0011909      | 0.0011954          |
| Arg of Perigee | 132.8883       | 86.6424        | 320.4373       | 321.8478       | 319.099        | 320.3633       | 319.4694           |
| Mean Anomaly   | 227.3056       | 273.6256       | 39.5996        | 38.1919        | 40.9403        | 39.6681        | 40.56              |
| Mean Motion    | 15.3184973     | 14.69579928    | 14.29970601    | 14.30017247    | 14.30160709    | 14.30127395    | 14.30243599        |
| Decay Rate     | 0.00004461     | 0.0000013      | 0.00000018     | 0.00000005     | 0.00000053     | 0.00000009     | 0.00000031         |
| Epoch Rev      | 2918           | 72385          | 39851          | 39852          | 39855          | 39854          | 39858              |
| Satellite      | UO-22          | KO-23          | KO-25          | IO-26          | POSAT          | Mir            | Phase 3D 502 (est) |
| Catalog Number | 21575          | 22077          | 22828          | 22826          | 22829          | 16609          | 99934              |
| Epoch Time     | 97254.37312531 | 97254.20258081 | 97254.16899868 | 97254.15537871 | 97254.19107124 | 97254.35585313 | 96260.25520000     |
| Element Set    | 799            | 717            | 563            | 597            | 585            | 590            | 3                  |
| Inclination    | 98.2922        | 66.0815        | 98.5364        | 98.5387        | 98.5312        | 51.6557        | 60.0203            |
| RA of Node     | 311.8395       | 325.135        | 326.8111       | 326.7078       | 326.9272       | 12.8844        | 342.7876           |
| Eccentricity   | 0.0007748      | 0.0004716      | 0.0010332      | 0.0009614      | 0.0009501      | 0.000446       | 0.6752895          |
| Arg of Perigee | 3.7951         | 194.5184       | 339.7058       | 356.1784       | 340.5343       | 123.5825       | 180.1221           |
| Mean Anomaly   | 356.3293       | 165.5686       | 20.3714        | 3.932          | 19.548         | 236.6253       | 179.5089           |
| Mean Motion    | 14.37083306    | 12.86303703    | 14.28190184    | 14.27845761    | 14.28175314    | 15.60058396    | 1.51063968         |
| Decay Rate     | 0.00000045     | -0.00000037    | 0.00000065     | 0.00000042     | 0.00000049     | 0.00013476     | 0.0002             |
| Epoch Rev      | 32286          | 23881          | 17448          | 20635          | 20640          | 66047          | 2                  |



The one-third scale model of Sputnik I on display at the AMSAT-UK Colloquium. Constructed by AMSAT-France, to be deployed on *Mir* on or about October 4, 1997. (W2RS photo)

- Beacon frequency is not presently final but is expected to be between 145.810 and 145.850 MHz.

For WWW info see:  
<http://www.oceanes.fr/~fr5fc/angspoutnik.html>

### AMSAT-DC Seminar

The Fall 1997 semiannual Local Maryland-DC Area AMSAT meeting and seminar will be held Sunday afternoon, November 2, at 1:00 pm at the Visitor Center Auditorium at the NASA Goddard Space Flight Center, Greenbelt, MD. Informal talk-in on WA3NAN/R 146.835

MHz Greenbelt. The phone number at the VC is 301-286-8981. Free parking.

All topics will relate to amateur radio, the amateur space program, and balloon and aerospace experiments. The format will be a combination of presentations and informal *show 'n' tell* demonstrations as well as a social period. Members are invited to bring in a "show 'n' tell" item or project that you have been working on. Please contact Pat Kilroy, WD8LAQ ([wd8laq@amsat.org](mailto:wd8laq@amsat.org)) in advance if you'd like to speak at the gathering. The GSFC Visitor Center is open to the public on this meeting day between 9 a.m. and 4 p.m. Something for the whole family!

Check for the latest developments by browsing the Local Maryland-DC Area AMSAT Web Page at <http://garc.gsfc.nasa.gov/~simsat/ssamsat.html>

### Dennis Caton, KF0JT, SK

It is with sadness that I report the death of Dennis Caton, KF0JT, author of *UP/DOWN*. Dennis lost a three year battle with cancer June 4, 1997 at his home near

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Colorado Springs, Colorado. He was a native of England and is survived by his wife and two grown children. Dennis was a long time supporter of AMSAT and satellite projects. For a time he was AMSAT's coordinator for activities at the Air Force Academy. When he hit upon the idea for the UP/DOWN program he was delighted to have found a way to contribute to AMSAT and satellite operations. (by Jim White, WD0E via AMSAT-BB)

### Mir Achievement Award

For those of you who have worked *Mir* both *voice* and *packet* there now is available a beautiful 8x10" card, with your personal call sign. This achievement award is yours for a donation of \$10.00 USA dollars. Your donation includes all shipping and handling costs. Your QSL card or a postcard showing your name, address, is required. Mail requests to: Dr. Dave Larsen, PO Box 1501, Pine Grove, CA 95665.

Meanwhile, Gregory Mann, WF1F Sysop East Coast for *Mir* provides some tips for working *Mir* packet.

*Mir* is a single user mail box. All stations must wait until the existing connected station logs off or times out from *Mir*. The message *ROMIR-ICQUI* means, the mail box is *open* and ready for the next log in. After you log in to the *-1* port, you can send a message using the standard command *SROMIR*. Note 0 means *zero* and not the letter OH. Enter the *Subject*, then when you see the *Message* prompt, enter the rest of your file from your *disk*. Typing by hand is too slow. It is recommended that you master a terrestrial BBS first, before going on to the *Mir* Personal Message System. Also try to keep your connect time to two minutes or less, so other stations waiting may have a chance to contact *Mir*.

### Vladimir Titov, KD5AOS

Bruce Paige, KK5DO informs us that Vladimir Titov, KD5AOS passed his Technician's license examination at the Clear Lake Amateur Radio Club, Texas. Vladimir is scheduled to fly on September 1997 shuttle mission that docks with the *Mir*. Vladimir told Paige that he was taking U.S. examination because he would not be able to use his Russian callsign from the shuttle. This way, he can use either callsign depending on which heavenly body he is aboard.



Central States VHF Society Chairman Gerald Hanley, WA5DBY (I) accepting plaque from AMSAT-NA Vice President Bill Tynan, W3XO for their ongoing support for Phase 3D totaling more than \$2,500. The plaque was presented at the Central States VHF meeting in Hot Springs, Arkansas on July 26, 1997. (Photo courtesy via Rich Moseson, W2VU, CQ VHF magazine)

### RS-10/11 Silent

Various reports have said that, since late on May 25 or early on May 26, 1997, RS-10/11 has been silent. Jess Burmeister, KB0VUU, reports making two contacts on RS-10 on May 25, 1997. These contacts occurred at 1745UTC with KB4LCI and at 1930UTC with N0IBT. But, on May 26, 1997 at 1630 UTC Steve Ford, WB8IMY, reported he heard nothing, not even the beacon. Since May 26th, the AMSAT News Service received several other reports from around the world confirming RS-10 is silent. Mark Behrens, W4GP, states he checked all of the A, K, and T beacon

frequencies for RS-10 and 11 and heard nothing. This pass started in eclipse and came into the Sun about half way through.

Meanwhile, Pat Gowen, G3IOR provided AMSAT-BB part of a message received July 10, 1997, from Leonid Labutin, UA3CR, regarding the status of RS-10. The message stated:

"Yesterday I had a meeting with Alex Papkov at GCC. We talked about RS10 and other problems. He thinks there is 1 - 2 percent possibility restoring RS-10. Cross your fingers....."



AMSAT was well represented at the BARC Hamfest held in Charlotte, Vermont in mid-August 1997. Various satellites were worked using W3ZM/1, the AMSAT-NA club call sign. The AMSAT crew included (left to right) Bob DeVarney, WE1U; Clif Lang, N1RYS; Tom Whitney, N1GZZ, Mike Seguin, N1JEZ; Beau Bushor, N1MJD; and George Cashwell, W1ME. (N1JEZ photo)

## SAREX Team Receives NASA Award

On Tuesday August 12, the Shuttle Amateur Radio EXperiment (SAREX) team received a NASA Johnson Space Center Group Achievement Award. This award was given to the SAREX volunteers to recognize the superb efforts put forth on the STS-94 mission. The award was given during the STS-94 mission debriefing session. SAREX Principal Investigator Matt Bordelon, KC5BTL, accepted the award for the SAREX team. The citation on the award reads, "For your outstanding support during STS-94 that allowed us to contact 17 schools around the world and make multiple contacts with Mike Foale aboard the Space Station *Mir*." AMSAT Vice President for Manned Space Programs Frank Bauer, KA3HDO, said this to his team of AMSAT volunteers when he informed them of their prestigious achievement: "The STS-94 crew was duly impressed with the preparedness of the SAREX schools, the tremendous bridge contacts, the great contacts with Mike Foale and the smoothness of the STS-94 SAREX flight operations. I want to thank you all for your tremendous support on this and all the activities that you do for SAREX, *Mir* and ARISS. You consistently make me proud". AMSAT-NA extends its congratulations to the entire SAREX team for their efforts which led to the reception of this NASA award.

## Gulf of Mexico AO-27 DXpedition

Eddie Pettis, N5JGK informs us that he will be working AO-27 QRP/maritime mobile from the cruise ship *M/S Enchanted Isle* during October 25-31, 1997. Departing out of New Orleans, N5JGK will use GPS to determine and work rare grid square locations. Key AO-27 passes to work N5JGK are on October 26th and 31st. Watch ANS for additional information on this DXpedition.

## KO-23 Turns Five

Kyung Hee Kim, HL0ENJ reports via AMSAT-BB that KO-23 celebrated its fifth birthday on August 11, 1997. Though the predicted lifetime for KO-23 is five years, her health remains good and there is much hope for many more birthdays!

## Totally Accurate Clock-2 Available

Tucson Amateur Packet Radio (TAPR) recently announced that version 2 of *Totally Accurate Clock* (TAC-2) is now available in kit form. TAPR has been working with Tom Clark, W3IWI, to make an improved version of the TAC available to all. TAC-2 Rev C of the kit is now available from TAPR. The TAC-2 kit is intended to serve several purposes by providing:

- a universal electrical and mechanical interface for a number of common OEM board-level GPS receivers including:

- Garmin GPS-20
- Motorola Oncore
- Trimble SK8

- interfaces for the 1 pulse-per-second (1PPS) signal generated by these receivers:

- Low-impedance, fast rise-time 1PPS signals for "laboratory" applications.
- RS232 level 1PPS signals for computer applications.
- Specialized 1PPS interfaces for an add-on PCB that will stabilize a low-cost crystal oscillator to an accuracy ~ 1 part-per-billion

- several different power supply options to make use of your GPS receiver easier. The power interface is similar to (and compatible with) those used for computer disk drives:

- A low-cost, (7805-type) regulator.
- A high-efficiency switching power supply.
- Direct 5 volt power.

- a provision for an Uninterruptable Power Supply (UPS) to buffer the GPS receiver through brief power outages.

- battery backup so the GPS receiver can wake up *smart*.

- isolated power for an amplified GPS antenna.

Since TAC-2 has so much flexibility, there are several options you will have to choose from during construction. The *base* implementation will satisfy the needs of many Radio Amateurs with support for the Garmin GPS-20 and Motorola ONCORE

Basic receivers. A few jumper changes enable support for the Motorola ONCORE VP/UT receiver. Some added parts and some more jumper changes are needed if you plan to use a Trimble SK-8.

TAC-2 is offered as a kit which will take approximately two to three hours to build, has been designed to be very easy to assemble. TAPR supplies detailed *Heathkit-like* instructions that only require you to know which end of the soldering iron is hot and a little knowledge on how to put things together!

One of the major interests that TAPR has in GPS timing is in the use of GPS as a way to steer (*discipline*) an oscillator. By tying together a low-cost crystal oscillator and a GPS receiver, it is possible to have a Rubidium-class (better than one part per billion) frequency standard. The TAC-2 has been designed to support this function and the TAC-2 project team is working on developing the TAC Oscillator Controller (TOC). The plan is that the TOC will plug directly into the TAC-2 circuit board. More information on this project will be made available as progress is made. No time is set for delivery of this daughterboard at this time.

The price is \$125.00 US for members of TAPR or \$139.00 US for non-members plus \$5 for domestic shipping and handling. The kit includes:

- TAC-2 Rev C PCB Board
- All necessary parts for the TAC-2 to allow interface to either the Oncore VP or Garmin GPS-20
- Documentation

Please note: This is not an enclosed unit. Enclosures are being worked on, but will not be available until the Fall. To order one TAC-2 contact TAPR at:

- E-mail: [tapr@tapr.org](mailto:tapr@tapr.org)
- Telephone: 940-383-0000
- Facsimile: 940-566-2544
- WWW: <http://www.tapr.org/tapr/html/tac2.html>



# AMSAT-UK Colloquium Photos

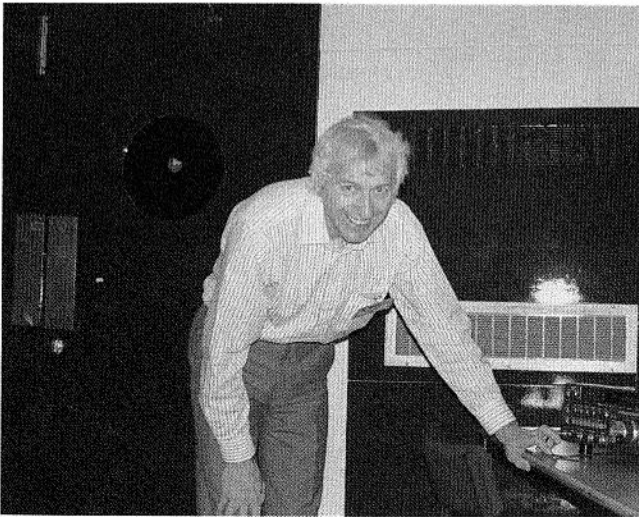
## Ray Soifer, W2RS



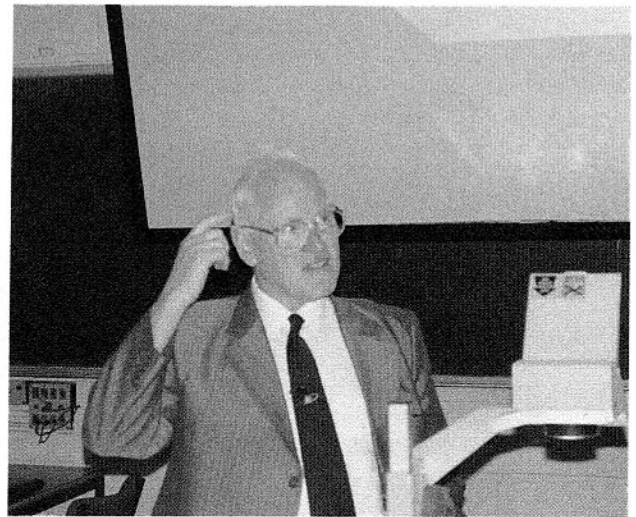
**Ian Kyle, G18AYZ/M10AYZ, President of RSGB, opens Saturday morning's session with a welcoming address. (W2RS photo)**



**Bernard Pidoux, F6BVP, holding Sputnik I model (See article on page 27) in the AMSAT-UK shop. (W2RS photo)**



**James Miller, G3RUH, demonstrating the Phase 3D ranging system (see article on page 6) which he designed and built. (W2RS photo)**



**Geoff Perry, MBE giving the G3CDK Memorial Lecture titled *The Kettering Group: From Hobby to Profession/Obsession*. (W2RS photo)**



**Ron Broadbent, MBD, G3AAJ, Hon. Secretary for AMSAT-UK, presenting the completed AMSAT-UK Call Sign Plaque to be flown aboard Phase 3D. (W2RS photo)**



**A group photo of the AMSAT-UK Colloquium participants. (W2RS photo)**



# IC-821H

**"By far the easiest to use satellite radio on the market today.** In less than 10 minutes after unpacking the 821H, I was on the air at 9600 baud with KO-23."

*—Michael Wyrick, N4USI  
AO-27 Control Operator*



## QST Magazine says:

"(The IC-821H) is a terrific dual-band multimode transceiver for all applications. Not only is the IC-821H an excellent VHF/UHF weak signal or contest radio, it is the cornerstone of a high-performance satellite station (digital or analog). Hams who have the Phase 3D satellite in mind will want to give serious consideration to the IC-821H. It also offers superb FM-voice and 9600-baud packet performance. Combine all of these features with the IC-821H's go-anywhere size and you have a radio that's ideal for almost any application above 144 MHz!"

— QST Magazine, March 1997  
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## 2M/440MHz All Mode Dual Band Base Station *More Satellite Fun for EVERY Ham!*

### Sub Band Transmit and Independent Main/Sub Band Reception

Enjoy cross band full duplex operation! The IC-821H is really two separate receivers within one compact case. Use the independent RF attenuators, RIT, IF shift circuits, and scan functions. Each band also has its own S-Meter, squelch, volume control, and independent mode selection.

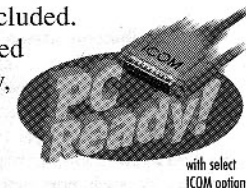
### Continuous Adjustable Transmit Power

Better than just using a high/low setting, the continuous adjustable transmit power feature is satellite "friendly". You'll get precise power control while you help extend the life of amateur radio satellites by running the minimum power necessary.

### 9600 Baud Plug and Play\*

Enjoy great 9600 baud packet operation right out of the box! There's a packet connection point right on the back of the rig. ICOM's famous CI-V serial communications port is included.

Visit your authorized ICOM dealer today, or call for a free brochure: (425) 450-6088



\*Options required for PC operation:  
CT-17 CI-V Level Converter,  
third party serial cable with pins 1-8 & 20,  
third party software

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*PC Powered!*  
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